Landscape, Livelihoods and Risk: Community Vulnerability to Landslides in Nepal

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Katie Jane Oven

The occurrence of fatal landslides in Nepal is increasing with time, faster than the effects of monsoonal variations. Possible explanations for the trends observed include: land-use change, population growth, and the development of transport infrastructure. However, to date, there is little evidence to support these postulated causes and very little research into the nature of landslide vulnerability in the Nepalese context. This research takes an interdisciplinary approach to examine, and where necessary, challenge a series of assumptions made regarding landslide vulnerability in Nepal with a view to developing a better understanding of social vulnerability and its underlying causes.

Firstly, a bottom up livelihoods based approach is adopted to examine the following research questions: (1) Who is vulnerable to landslide hazard?; (2) Why do people occupy landslide prone areas?; and (3) How do 'at risk' rural communities perceive and respond to landslide hazard and risk? In so doing, this thesis approaches the question of landslide vulnerability from the perspective of the vulnerable people themselves. Secondly, the research explores how scientists and policy experts view landslide risk management in Nepal and how policy is subsequently informed and shaped.

The findings highlight the impact of infrastructure projects in rural Nepal. Within the Upper Bhote Koshi Valley clear transitions in settlement patterns and rural livelihoods (and thus the occupation of landslide prone areas) have been seen over time. For the majority of households, their decision to occupy these areas is driven by the economic and social benefits associated with the road. Landslide risk therefore emerges not just from societal marginalisation but also from situations of relative prosperity. The findings suggest that occupants of landslide prone areas have a good understanding of landslide hazard and its associated risk. However, these risks are contextualised in relation to other social concerns. The significance of the findings for landslide policy and practice are addressed along with different actors' views of landslide risk management in Nepal.

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List of Acronyms and Abbreviations

ADB	Asian Development Bank
DDC	District Development Committee
DDRC	District Disaster Relief Committee
DFID	Department for International Development (UK)
DoR	Department of Roads, Government of Nepal
DOLIDAR	Department of Local Infrastructure and Agricultural Roads
DRILP	Decentralised Rural Infrastructure Project
DRR	Disaster risk reduction
GIS	Geographical information systems
HFA	Hyogo Framework for Action
ICIMOD	International Centre for Integrated Mountain Development
IDNDR	International Decade of Natural Disaster Reduction
INGO	International non-governmental organisation
ILC	International Landslide Centre, Durham University
LDC	Less developed country
LDO	Local Development Officer
MoHA	Ministry of Home Affairs
NCDM	National Centre for Disaster Management
NGO	Non-governmental organisation
RAP	Rural Access Programme
SDC	Swiss Development Cooperation
SL	Sustainable livelihoods
SLA	Sustainable livelihoods approach
THED	Theory of Himalayan Environmental Degradation
UNDP	United Nations Development Programme
UN-ISDR	United Nations International Strategy for Disaster Reduction
VDC	Village Development Committee
WCDR	World Conference on Disaster Reduction

I confirm that no part of the material presented in this thesis has previously been submitted by me or any other person for a degree in this or any other university. In all cases, where it is relevant, material from the work of others has been acknowledged.

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For my parents, Jane and Richard

Pool at your peril. Two very common images of the Central Himalaya: rock slides and outdoor snooker tables. Photo by Basil Pao. Source: Palin (2004).

Chapter 1

Landscape, Livelihoods and Risk: An Introduction

1.1 Introduction

I met Pemba Sherpa in October 2006 outside his temporary house in the roadside village of Larcha in the Upper Bhote Koshi Valley, Central Nepal (Fig. 1.1). Pemba, his wife Dolma, and their three daughters aged 7, 12 and 14, moved to Larcha in 1996 from the nearby hill village of Duguna, approximately three hours walk from the road. With limited opportunities in the village, Pemba and his wife wanted to move to the roadside to set up a business. Pemba worked in a plastics factory in Malaysia between 2002 and 2005 and with his savings purchased the land in Larcha shortly before the 1996 debris flow disaster which buried the roadside settlement killing 54 people. The family moved to Larcha approximately one month after the disaster and began to build their house. Their concerns over the recurrence of a debris flow were overshadowed by the livelihood and economic opportunities associated with their roadside location. They set up a business importing brandy from China, and Dolma makes local alcohol which they sell from their home. Ten years on and Pemba is building a new stone house with the money they have made through their business. This was not a destitute, landless household being forced to migrate into a landslide prone area. This was a household who, knowing the risks, made a decision to migrate, the outcome of which was a degree of improved economic prosperity.

The experience of Pemba Sherpa and his family illustrate many of the core issues which this thesis sets out to examine. The research takes an interdisciplinary approach to investigate the vulnerability of rural communities to landslides in the Nepal Himalaya. Firstly, a bottom-up livelihoods-based approach is adopted to examine the following research questions: (1) Who is vulnerable to landslide hazard?; (2) Why do people occupy landslide prone areas?; and (3) How do 'at risk' rural communities perceive and respond to landslide hazard and risk? In so doing, this thesis approaches the question of landslide vulnerability from the position and perspective of the vulnerable people themselves. Secondly, the research explores how scientists and policy experts view landslide risk management in Nepal and how policy is subsequently informed and shaped.

Figure 1.1 A landslide prone roadside settlement in the Upper Bhote Koshi Valley, Central Nepal

1.2 Landslides: an underestimated hazard

Landslides have been characterised as one of the most destructive geological processes often resulting in major loss of life and economic damage (Brabb 1993; Lee and Jones 2004). Between 1990 and 2006 landslides caused more than 100,000 fatalities worldwide (Petley 2008). Major disasters include the 2005 South Asian earthquake which triggered extensive slope failures resulting in an estimated 25,000 fatalities (Dunning *et al.* 2007) and the 2008 Wenchuan earthquake in Sichuan, China which triggered more than 15,000 landslides resulting in approximately 20,000 deaths (Yin *et al.* 2009). Other significant events include the landslides triggered by Hurricanes Jeanne and Ivan in Haiti in 2004 which caused more than 3,000 fatalities (UNEP/OCHA 2004) and a debris avalanche which buried the town of

Guinsaugon in Southern Leyte, in the Philippines in 2006 killing 1,126 people and displacing an additional 19,000 people (Catane *et al.* 2006).

Landslides are a significant component of many major natural disasters and are often responsible for greater loss of life and livelihoods than is generally recognised. This is largely because they are often recorded according to the triggering event such as an earthquake or hurricane even though the losses from landslides may exceed all other losses from the overall disaster (Spiker and Gori 2000). In addition, high frequency, low magnitude events often go unreported. As noted by Lavell (1994) and Wisner (2001), while emphasis is often placed on high magnitude, low frequency events, it is the small and medium sized events which are localised and affect small numbers of people which cumulatively account for similar or greater levels of economic loss than less frequent large-scale events. Indeed the magnitude frequency distribution of fatality inducing landslides follows a power-law, such that single fatality small-scale failure events (<10m^2) account for significant numbers of deaths (Petley and Rosser in press).

The available data show an overall increase in the number of landslides and associated fatalities with time. Initially, the most obvious explanation for the rising occurrence of fatal landslides is an increase in the level of geological and meteorological activity triggering mass movement. However, this is in conflict with the general acceptance that long-term frequency of natural events has remained more or less constant (Uitto 1998). The trend is therefore largely ascribed to human and social factors rather than changes in physical systems for example, underdevelopment, poverty and marginalisation, factors affecting the vulnerability of the population (Hewitt and Burton 1971; Susman *et al.* 1983).

1.3 Landslide activity in Nepal

An increase in fatal landslide activity has also been observed in Nepal which, from a geophysical perspective, is extremely vulnerable to natural disasters (Tianchi and Behrens 2002). Located along the Himalayan Arc, Nepal lies in a tectonically active zone characterised by high relative relief (83% of the territory is mountainous terrain (Adhikari and Koshimizu 2005)) and differential uplift (Jackson and Bilham 1994). Nepal experiences a summer monsoon regime characterised by a strong north-westerly flow of moisture laden air from the Indian Ocean from June to September which accounts for 70-93% of its annual precipitation. High seismicity, steep and unstable slopes, active geodynamic processes and intense monsoon rainfall make the Nepal Himalaya a dynamic mountain environment highly susceptible to floods, landslide dam-break floods, glacial lake outburst floods and earthquakes, in addition to landslides themselves. Landslides, along with floods, have been identified as the most frequent, costly and deadly disasters in Nepal affecting more than 32,000 households per year (Tianchi and Behrens 2002).

In addition to these physical characteristics, Nepal is classified as a low income developing country and a low human development nation, ranked 142 out of 177 countries in the composite human development index[1] (UNDP 2007). An estimated 82% of the population can be classified as 'rural' (UN Statistics Division 2009), living in extreme poverty and depending upon weak agricultural production as their only source of cash income (Tianchi and Behrens 2002). Nepal is characterised by inequality based on socio-economic factors including ethnic and caste discrimination (Pradhan and Shrestha 2005). The high castes and relatively advantageous groups (including the Brahmin-Chhetri-Newar) constitute only 37.1% of the population, yet their human development indicators can be up to 50% greater than the hill ethnic, Terai ethnic and occupational caste groups (Murshed and Gates 2005). These groups are often excluded from the socio-economic and political mainstream and as a result frequently occupy very marginal locations (Bhattachan and Webster 2005). This raises a series of questions regarding community risk and vulnerability to landslide hazards which at present are poorly understood.

Petley *et al.* (2007) examined trends in fatal landslide activity in Nepal between 1978 and 2005. The findings show a high level of variability from year to year, but with an overall upward trend (Fig 1.2). Further analysis of these data suggests there is cyclicity in the occurrence of landslide fatalities in Nepal that strongly mirrors the cyclicity of the south west summer monsoon in South Asia (See Chapter 2 for a more in-depth discussion). However, Petley *et al.* (2007) go on to note that the number of landslide fatalities have, in recent years, increased dramatically over and above the effects of the monsoon cycle. This trend has been attributed to a range of factors including: population growth and urbanisation (Alexander 2005; Keefer and Larsen 2007); land-use change resulting from intensive deforestation, unsafe irrigation practices and quarrying (Gerrard and Gardner 2000a; Schuster and Highland 2001; Alexander 2005; Sudmeier-Rieux *et al.* 2007a); infrastructure development beyond the capacity of the slopes (Gerrard and Gardner 2000a; Bernard *et al.* 2001; Sidle *et al.* 2006; Sudmeier-Rieux *et al.* 2007b; Owen *et al.* 2008); and the effects of (anthropogenic) climate

[1] The human development index provides a composite measure of three dimensions of human development: life expectancy; adult literacy and enrolment at the primary, secondary and tertiary level; and standard of living, measured by purchasing power parity (UNDP 2007).

change which may be changing rainfall patterns and intensities (Petley *et al.* 2005a). In addition, increasing vulnerabilities may also be attributed to the decade–long civil conflict, which has exacerbated poverty levels, and led to the migration of people from Maoist controlled rural areas to government controlled population centres (Haack and Rafter 2006; Hatlebakk 2007). However, there is little evidence to support these postulated causes and, indeed, there is very little research into the nature of vulnerability in the Nepalese context.

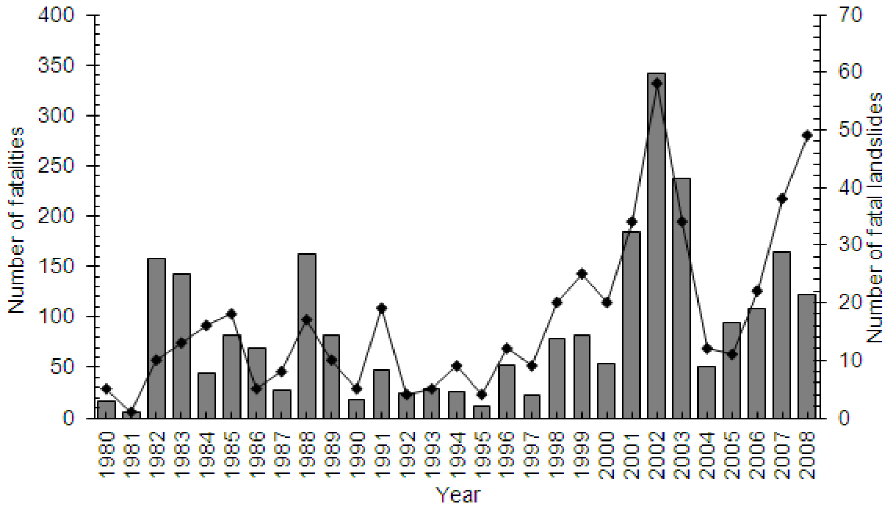


Figure 1.2 Number of landslide fatalities (bar graph, left hand scale) and number of fatal landslides (line graph, right hand scale) each year for the period 1978-2008 for Nepal. Source: International Landslide Centre (2009).

1.4 Research questions

This research seeks to examine and, where necessary, challenge a series of assumptions made in the context of landslide vulnerability in Nepal with a view to developing a better understanding of social vulnerability and its underlying causes. As noted by Alexander (2005) much is now known about the physics of landslide hazards, but landslide vulnerability remains a more elusive concept, dependent upon seemingly nebulous patterns of decision-making, response and behaviour. This study places the people who experience landslides at the centre of the research with the aim of *'delineating the landscape of vulnerability'* (Hilhorst and Bankoff 2004: 1). In so doing, this research seeks to address the following questions:

1. Who is vulnerable to landslide hazard in the Nepal Himalaya?
2. Why do people occupy landslide prone areas in Central Nepal?
    a. What are the factors and forces shaping current day settlement patterns and how have these patterns evolved?
    b. What are the risks and opportunities driving settlement patterns and where do landslides sit amongst these drivers?
3. How are landslide hazards perceived and understood by 'at risk' rural communities?

   a. What socio-cultural factors influence these perceptions?
   b. How is landslide risk contextualised in relation to everyday livelihood issues and concerns; and in terms of the rationalities local people bring to bear?
   c. How do households choose which risks to ignore and which risks to manage?
4. How do people respond both immediately, and in the long term, to landslide hazard and risk in rural Nepal?
   a. What coping strategies do households and communities adopt and what socio-cultural factors influence these responses?
   b. How do local people view the existing institutional arrangements for landslide risk reduction?
5. How is landslide policy in Nepal informed and shaped, and how has this changed over time?
   a. To what extent have intellectual debates within the field of hazard and risk research impacted upon policy-maker thinking?
   b. How divergent are different actors' views of landslide risk in Nepal?
   c. Does current policy adequately reflect the needs of the exposed households?

The research was undertaken in the Upper Bhote Koshi Valley, Sindhupalchok District, Central Nepal where a number of landslide prone settlements were identified. The study focused on three roadside settlements: Chaku, Larcha and Kodari. Shortly after arriving in the Upper Bhote Koshi Valley, I discovered that the majority of inhabitants of the roadside settlements had migrated from hill villages in the surrounding hinterland. Consequently, a significant part of my research took place in three example off-road settlements: Marmin, Duguna and Listi. This provided me with the opportunity to explore the factors and forces driving the human occupation of landslide prone areas.

1.5 The structure of the thesis

1.5.1 Organising frameworks

This thesis focuses on the everyday lives and 'situated contexts' of householders and communities and their decision-making environments. I have loosely adopted Wisner *et al.'s* (2004) Pressure and Release (PAR) model which maps the progression of vulnerability from root causes to unsafe conditions; and the Access model which, similar to the sustainable livelihoods framework (Carney 1998), views livelihood strategies as the key to understanding how people cope with hazards. The focus of this research is, therefore, the everyday. As noted by Rigg (2007), understanding the impacts and effects of disasters, such as the Larcha debris flow, introduced at the beginning of this chapter, requires that the events are embedded in everyday geographies. How and why people and communities respond as they do is intimately linked to local historical trajectories, local cultural norms, and social structures (ibid).

One of the key challenges of this research was bringing together disparate bodies of work in the natural and social sciences. While the need for collaborative research within the hazards field is well recognised (see, for example, Pelling 2003) moving from theory to practice has presented a number of significant challenges. Firstly, epistemologies differ between specialisms. How researchers develop their research questions and select the methodologies to explore these questions varies between physical and social science (see, for example, Bracken and Oughton 2006; Massey *et al.* 2006; Jones and Macdonald 2007). This presents a series of difficulties when designing, 'doing' and writing-up inter-disciplinary research. A second major challenge relates to the integration of different knowledges, for example, scientific knowledge, people's (grounded) knowledge and discipline specific knowledge. While research may set out to be interdisciplinary in nature, the findings are often disseminated by individuals from the perspective of, and for, their particular specialism.

While I was not conducting this research as part of an interdisciplinary team of researchers, I nonetheless found myself grappling with these issues and being pulled in a number of different directions at each stage of the research (this will be explored in greater detail in Chapter 5). On the one hand it could be argued that this is a social science thesis about a physical topic. On the other, it could be viewed as a physical science thesis about a social science topic. I have, to a large extent, let my findings dictate the direction of the research and integrated the different approaches and world views of both physical and social scientists. In so doing, I have constructed a series of detailed geomorphological maps which have provided a scientific evidence base which has been used to explore local understandings of, and responses to, landslide hazard and risk, and landslide risk management policy, both from a constructivist perspective.

1.5.2 The chapters

Structuring this thesis given the interdisciplinary nature of the research has proven to be particularly challenging since I did not want to separate the natural from the social science aspects. Rather, I set out to weave the two together. I am not sure to what extent I have succeeded in this – indeed, I start out by partitioning the natural and social science as a way into the thesis. Overall, the thesis can be divided into four sections. The first section provides the background to the research including the conceptual and theoretical frameworks that have shaped the study (Chapters 2 and 3). The second section, introduces the methodological approaches adopted. It then integrates literature sources with contemporary field data collected within this thesis to determine the geophysical and social vulnerability context for the six case study settlements in the Upper Bhote Koshi Valley (Chapters 4, 5 and 6). Section three draws further on this empirical data to discuss local understandings of, and responses to, landslide hazard and risk (Chapters 7 and 8). The fourth and final section (Chapters 9 and 10) combines primary and secondary material and explores how landslide policy is informed and shaped and to what extent this adequately reflects the experiences of the communities at risk.

Section 1

Chapter 2, The Nature of Landslide Hazard, provides an overview of the geophysical process of landsliding including the causes, triggers and mechanisms of slope failure. The chapter goes on to examine the spatial and temporal trends in landslide activity in Nepal specifically.

Chapter 3, Framework and Theory, sets out the key conceptual and theoretical frameworks, including risk and vulnerability, which will be drawn on throughout the thesis. The interdisciplinary nature of the research means a number of different frameworks have shaped the study.

Section 2

Chapter 4, Geomorphological Context, provides an overview of the settlement distribution and the nature of landslide hazard in the Upper Bhote Koshi Valley. The chapter introduces each case study settlement in turn and presents a series of geomorphological maps created through field mapping and satellite imagery analysis, providing a context for later empirical data.

Chapter 5, Researching Landslide Vulnerability, gives an overview of the qualitative and quantitative methodologies used and the experience of undertaking research on landslide vulnerability in Nepal.

Chapter 6, The Changing Geographies of Risk and Opportunity, combines primary and secondary material to explore changing settlement patterns in the Upper Bhote Koshi Valley and what this means in terms of exposure to landslide hazard. The chapter goes on to explore the multiple-factors influencing the human occupation of landslide prone areas. These factors are discussed in the context of household decision-making and the notion of 'choice'.

Section 3

Chapter 7, Local Understandings of Landslide Hazard and Perceptions of Risk, is largely based on empirical data from village meetings, household surveys, semi-structured interviews and participatory mapping sessions. The analysis is informed by the earlier theoretical discussion on risk perception and well-being research (Chapter 3). The chapter asks how landslide hazard and risks are perceived and understood and how risks are viewed in relation to everyday livelihood concerns.

Chapter 8, Household and Community Response to Landslide Hazard and Risk, considers local level responses to landslide risk across the six case study settlements. Drawing on semi-structured interviews and oral histories I begin by examining household and community interest in landslide risk reduction and the agency and capacity of individuals, households and communities to respond to landslide risk. This includes the mitigation and management of the landslide hazard and resilience building at the grass roots level. Finally, the chapter considers how local people view the existing institutional arrangements for landslide risk management.

Section 4

Chapter 9, Institutional and Expert Understanding of Landslide Risk in Rural Nepal, combines primary and secondary material. Here I explore how landslide policy is informed and shaped, to what extent the policy works in practice and whether current policy adequately reflects the situation on the ground.

Chapter 10, Landscape, Livelihoods and Risk: Towards A Reflexive Approach, draws my arguments together and contributes to debates around landslide risk management in both Nepal and other developing country contexts. In this chapter I set out a series of challenges and propose areas for further research.

Chapter 2

The Nature of Landslide Hazard

2.1 Introduction

This chapter provides an introduction to the nature of landslide hazard. Beginning with an overview of the geophysical process of landsliding including the causes, triggers and mechanisms of slope failure, the chapter goes on to examine landslide activity in Nepal specifically, including the spatial and temporal trends in landslide occurrence and their impact.

2.2 Landslide mechanisms and type

The term landslide refers to the movement of slope-forming material including rock, debris or soil, under gravity (Cruden and Varnes 1996; Glade and Crozier 2005a). The type of movement (including falls, slides and flows) is determined by a number of factors that include the geology, material strength, slope configuration and external forcing such as pore water pressure (Dikau *et al.* 1996) (Table 2.1). Landslides may move quickly down slope, at several metres per second, may creep at very slow rates of only a few millimetres per year, or may stall for extended periods (Glade and Crozier 2005a).

Table 2.1 Landslide classification based on Dikau *et al.* (1996).

Process	*Material*		
	Rock	*Debris*	*Earth*
Fall	Rock fall	Debris fall	Earth fall
Topple	Rock topple	Debris topple	Earth topple
Rotational slide	Single (slump)	Single	Single
	Multiple	Multiple	Multiple
	Successive	Successive	Successive
Translational slide	Block slide	Block slide	Slab slide
Planar	Rockslide	Debris slide	Mudslide
Lateral spreading	Rock spreading	Debris spread	Earth spreading
Flow	Rock flow	Debris flow	Earth flow
Complex	e.g. rock avalanche	e.g. flow slide	e.g. slump -earth flow

Source: Glade and Crozier (2005a: 47).

2.3 Physical causes and triggering mechanisms

Slopes can be viewed as existing at a given point along a spectrum of stability, ranging from ‘stable’ with low probabilities of failure, to unstable ‘actively failing slopes’ (Glade and Crozier

2005a). Marginally stable slopes reside between these states on this spectrum. Such slopes are not currently undergoing active failure but may be susceptible to failure at anytime in response to dynamic external forces when they exceed activation thresholds (Fig. 2.1). Glade and Crozier (2005a) identified four groups of factors promoting slope instability:

- **Precondition or predisposing factors** are static, inherent factors which influence stability e.g. geology and material strength.
- **Preparatory factors** are dynamic factors that reduce the stability of a slope over time without actually initiating movement. Facilitated by preconditions, preparatory factors are responsible for shifting a slope from a 'stable' to a 'marginally stable' state. Some factors, such as weathering and tectonic uplift, operate over long periods of geomorphic time (see, for example, Shroder and Bishop 1998). Others may be effective over shorted time periods for example, slope over-steepening by toe erosion (Preston 2000), deforestation (Schmidt *et al.* 2001) or slope disturbance by human activity (Rybar 1997).
- **Triggering factors** initiate the movement of a slope from a 'marginally stable' to an actively 'unstable state'. The most common triggering factors include high intensity precipitation, prolonged periods of rainfall and seismic shaking.
- **Sustaining factors** dictate the ongoing behaviour of 'actively unstable' slopes for example, the duration, rate and form of movement. Sustaining factors may be dynamic external factors such as rainfall or the terrain with which the landslide interacts down slope.

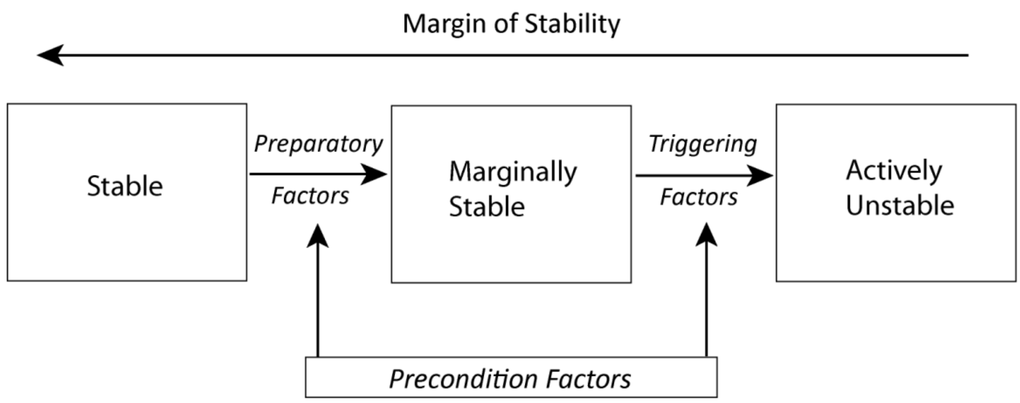


Figure 2.1 Slope stability and destabilising factors based on Crozier (1989) (source: Glade and Crozier 2005a: 45)

Landslides can have several causes (Table 2.2) and these may be geological, morphological, physical or human in nature, but only one trigger (Varnes 1978; Cruden and Varnes 1996). The term trigger refers to an external stimulus for example, intense rainfall, rapid snow melt, seismic shaking or the failure of natural dams which cause an immediate or near-immediate response in the form of landslide activity (Schuster and Wieczorek 2002). The trigger may activate the landslide by rapidly increasing the shear stresses by ground acceleration due to seismic activity, by removing lateral support, by loading the slope, by increasing pore pressure, or by reducing the strength of slope materials. The most common natural landslide triggers include high intensity precipitation, rapid snowmelt, water-level changes, volcanic activity and seismic shaking (Wieczorek 1996).

Table 2.2 Landslide causes

Geological Causes	*Morphological Causes*	*Human Causes*
Weak or sensitive materials Weathered materials Sheared, jointed, or fissured materials Adversely orientated discontinuity e.g. bedding planes and faults Contrast in permeability and/or stiffness in materials	Tectonic or volcanic uplift Glacial rebound Fluvial, wave, or glacial erosion of toe slope or lateral margins Subterranean erosion Deposition loading slope or its crest Vegetation removal (by fire or drought) Thawing Freeze-thaw weathering Shrink-swell weathering	Excavation of slope or its toe Loading of slope or its crest Deforestation Irrigation Mining Artificial vibration Water leakage from utilities

Source: (USGS 2004)

Mass movements may occur instantaneously following a specific trigger or may occur following a delayed response to the critical triggering conditions, for example a prolonged rainfall event which gradually increases the pore-water pressure (Gerrard and Gardner 2000a; Glade and Crozier 2005a). This observation highlights the importance of antecedent conditions which may initiate slope instability (Gerrard and Gardner 2000a; Schuster and Wieczorek 2002).

Oven (2005) analysed the triggering mechanism of 482 fatal landslides recorded worldwide between 1994 and 2004 by the International Landslide Centre, Durham University. The study found that 87% of recorded landslides were triggered by high intensity or prolonged precipitation events often associated with the annual monsoon. These rainfall induced landslides caused 94% of the recorded fatalities. Earthquakes were a comparatively infrequent trigger, initiating only 4% of the fatal mass movements, which resulted in 4% of the recorded fatalities, though no high magnitude earthquakes affected this region during the study period. Other physical triggers included glacial lake collapse and heavy snow, which triggered 0.9% of events and 0.3% of fatalities. Additional events within the database were associated with mining and mineral excavation, road construction and embankment failure, triggering 7% of fatal landslide events and resulting in 0.7% of total fatalities. These findings affirm those of Alexander (1989; 2005) who analysed the occurrence and distribution of global landslide hazards, concluding that the predominant trigger of landslide activity was high intensity and prolonged rainfall, with earthquakes and volcanoes being a far less frequent trigger. It is important to note, however, that since the compilation of both databases, two significant earthquakes have occurred (Kashmir and Wenchuan), both of which triggered extensive multiple mass movements. While such events are relatively infrequent, when they do occur, their impact is often catastrophic and holds a significant influence on the long term average rate of landslide fatalities (see section 2.3.2).

2.3.1 Rainfall triggered landslides

Many studies have been undertaken examining the relationship between rainfall and landslide activity (Caine and Mool 1982; Froehlich *et al.* 1990; Wieczorek 1996; Glade 2000; Gerrard and Gardner 2000a; Dai *et al.* 2003; Gabet *et al.* 2004). This is largely associated with infiltration and increases in pore water pressures that reduce shear resistance on a slope and promote the downhill movement of material (Glade 2000). Storms that produce intense rainfall for relatively short periods (several hours) and more prolonged events of a more moderate intensity have been observed to trigger landslides in a number of regions (Wieczorek 1996). Landslide activity is often linked to large-scale weather systems including tropical cyclones, hurricanes, typhoon events[1] and the annual monsoon (Petley 2008). However, controls on landsliding appear to be due to topography, material characteristics, land-use patterns and antecedent moisture conditions; thus the likelihoods of failure will never be solely determined by a particular meteorological event alone (Gerrard and Gardner 2000a).

2.3.2 Earthquake triggered landslides

Earthquakes have long been recognised as a major trigger of landslide activity (Keefer 1984; Owen *et al.* 1995; Rodriguez *et al.* 1999). Recent examples from the South Asian region include the 2005 Kashmir earthquake which triggered several thousand landslides (Owen *et al.* 2008); and the 2008 Wenchuan earthquake in Sichuan, China which triggered more than 15,000 mass movement events (Wang *et al.* 2009; Yin *et al.* 2009). The occurrence of

[1] Tropical storms with a minimum mean wind speed of 33 m s^{-1} are termed typhoons in the Northwest Pacific basin, hurricanes in the Northeast Pacific basin and the Atlantic, and cyclones in the Southern Hemisphere and the Indian Ocean (Smith 2001).

earthquake induced landslides is based on two parameters: the susceptibility of the slopes to seismically triggered instability and the intensity of the earthquake shaking (Bommer and Rodriguez 2002). Studies undertaken examining the distribution of co-seismic landslides following the 1999 Chi-Chi earthquake in Taiwan, the 1989 Loma Prieta earthquake in California and the more recent Kashmir earthquake all suggest that earthquake triggered landslides are abundant in specific zones associated with bedrock geology, geomorphology, topography and human factors, with peak ground accelerations being the most significant triggering factor (Keefer 1984; Rodriguez *et al.* 1999; Owen *et al.* 2008). Landslides triggered by catastrophic earthquakes are predominantly shallow slides and small-scale rock falls, with less frequent high magnitude deep seated failures (Keefer 1984; Rodriguez *et al.* 1999; Owen *et al.* 2008; Yin *et al.* 2009).

Petley (2009) has explored the relationship between earthquake magnitude and the area affected by landslides. A database has been compiled which extends the work of Keefer (1984) and Rodriguez *et al.* (1999) who covered the period 1811 to 1997 to 2009 (Fig. 2.2). The resulting data shows a strong relationship between variables, but a high range of possible landslide outcomes for any given earthquake magnitude: a reflection of the variability of earthquake hypocentre depth, topography, antecedent conditions, vegetation and human activity (Petley 2009), and the potential inadequacy of a single magnitude figure to quantify impacts.

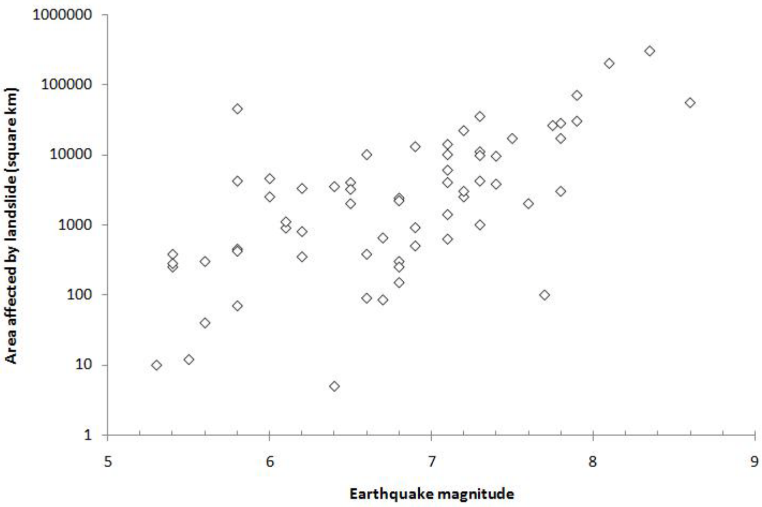


Figure 2.2 The relationship between earthquake magnitude and the area affected by landslides. Source: Petley (2009).

In addition to initiating slope failure, reactivation of existing landslides and new first time failures particularly along geological structures may also occur in earthquake affected areas following monsoon rains and snow melt (Kamp *et al.* 2008). For example, Bulmer *et al.* (2007) and Sudmeier-Rieux *et al.* (2007b) have reported landslide reactivation in the Lower Neelum Valley during subsequent monsoons following the 2005 Kashmir earthquake. In addition, earthquakes are known to produce a large amount of loose material, which can be subsequently reactivated or transported in debris flows. For example, Tang *et al.* (2009) have reported extensive debris flow activity following a heavy rainstorm in Beichuan County four months after the Wenchuan earthquake in September 2008. The significance of this secondary landslide hazard remains poorly understood.

2.3.3 Anthropogenic causes

A number of anthropogenic causes of increased landslide impact have been identified. These include:

1. *Population growth and urbanisation*

   The growth of cities has created areas of highly concentrated vulnerability to slope failure (see, for example, Steedman 1995), especially in less economically developed countries, where population growth and rural-urban migration can lead to the growth of urban slums on increasingly marginal land at the periphery of urban centres (Alexander 2005). Since 2008 more than half of the world's population, 3.3 billion people, have been living in urban areas and by 2030 this is expected to increase to 5 billion (Martine 2007). Ninety percent of this type of growth is predicted to occur in developing countries, many of which are subject to extreme natural events (POPIN 2003). Population growth is therefore considered to influence the impact of landslides by exposing more individuals to risk and by driving the development of more marginal, often less stable terrain (Petley *et al.* 2007).

2. *Deforestation*

   The loss of forests is thought to reduce the rate of evapotranspiration on slopes, leading to higher groundwater levels, to reduce cohesion through the loss of root strength and to increase overland flow, which enhances the rate of erosion (Crozier 2005). The effect of these changes is to render slopes increasingly sensitive to landslide triggers and to increase the mobility and hence hazard (i.e. the run-out velocity and hence distance) of slides once they have been initiated (Petley *et al.* 2007).

3. *Infrastructure development*

   The construction of roads is considered to increase the probability of landslides as a result of undercutting and loading from spoil disposal (see, for example, Sidle *et al.*

2006). According to Owen *et al.* (2008) the most common setting for landslides in Azad Kashmir, Northern Pakistan following the 2005 earthquake was associated with road construction. This supports the view of Keefer (1984), Owen *et al.* (1996) and Bernard *et al.* (2001) who all suggest that human modification of the landscape by road construction is one of the most influential factors in helping to initiate landslides in tectonically active regions.

4. *Anthropogenic climate change*

   Human-induced climate change has been linked with changing rainfall distributions and intensities. For example, warmer ocean waters in the tropics could result in a longer and more intense hurricane season (Emanuel 2005; Webster *et al.* 2005). Whilst the impact of climate change on monsoon duration and intensity remains ambiguous (see Solomon *et al.* 2007), Christensen *et al.* (2007) reported that the most recent climate models indicate an 11% increase in annual precipitation in South Asia by 2010, primarily as a result of increased rainfall during the monsoon period. This is in contrast to a study undertaken by Zhou *et al*. (2008) examining changes in monsoon precipitation over the recent half century. Their findings suggesting the monsoon has in fact weakened rather than intensified since 1950. The disparities apparent between such studies indicates the present limitations in our understanding of the likely future nature and pattern of landslide triggers, irrespective of the likely response of slope forming materials to these variations.

2.4 Landslide activity in Nepal

Nepal lies across the Main Boundary Thrust (MBT) along which much of the deformation associated with the collision of the Indian and Eurasian plate has been accommodated. This large, northward-dipping series of thrust plains have promoted the rapid and sustained uplift that has formed the young fold mountain chain of the Himalayas. It is well recognised that landslides occur extensively in the Himalaya (Owen *et al.* 1995; Sah and Mazari 1998; Barnard *et al.* 2001) and in Nepal in particular (Gerrard and Gardner 2000a; Petley *et al.* 2005b; Hasegawa *et al.* 2009). Here, landslides play a fundamental role in the evolution of the landscape, providing a mechanism through which mass balance can be achieved between uplift and erosion (Hovius *et al.* 2004; Petley *et al.* 2007). Landslides represent the most efficient process in non-glaciated environments through which material that has been advected into a mountain chain by tectonic processes can be released from the hillsides and fed into the fluvial system (Shroder 1998; Shroder and Bishop 1998; Petley *et al.* 2007).

The increasing impact of landslides in Nepal was demonstrated by Hart *et al.* (2003), who compiled a database of landslide activity over a 30-year period from archival research, focussing specifically on landslide fatalities. Some debate surrounds the most appropriate manner of assessing landslide impact. Petley *et al*. (2007) summarise this debate, arguing the globally transferrable fatality unit as the most appropriate comparative measure for global-scale databases. In the Nepal context this approach is appropriate given the high human cost of landslides, but it should be noted that in parallel to these highly simplified metrics lies considerable economic, social, and psychological disruption that could be argued to be equally significant in shaping the vulnerability of the affected population. Hart *et al.* (2003) recorded 185 fatalities in 2001 and 342 recorded fatalities in 2002, demonstrating a high inter-annual variability of landslide impacts. Petley *et al.* (2007) have since compiled a database of fatal landslide events in Nepal and analysed the longer-term trends in landslide activity. The remainder of this chapter draws on this research; I provide a copy of the main publication that came out of this work in Appendix 1.

For the period 1978-2005 a total of 397 fatal landslides were recorded in Nepal, which caused a total of 2,179 fatalities representing an average of 78 deaths per year (See Chapter 1, Fig. 1.2). The number of fatalities varies greatly from year to year with the smallest number of deaths occurring in 1981 when only five fatalities were recorded, while the largest number was 342 in 2002. A similar variation is noted in the number of fatal landslide events per year, which ranges from one in 1981 to 58 in 2002.

2.4.1 Spatial trends in fatal landslide activity

Nepal can be divided into three geographical regions (Fig. 2.3). In the south of the country lies the Terai, which accounts for 23.1% of the surface area and comprises flat, alluvial plains. These districts have comparatively high population densities of 329.59 persons per km^2 (Pantha and Sharma 2003). In the far north lie the Mountain districts incorporating the mountain massifs of the High Himalaya, which comprise 35.2% of the land area of Nepal. These areas are sparsely inhabited with a population density of 32.57 persons per km^2 (ibid). Between these two areas lie the Hill districts of the Middle Himalaya with peaks reaching c. 5,000 m and valleys less than 500 m asl producing high local relative relief. The population density of this area, which includes the Kathmandu Valley, is 167.11 persons per km^2 (ibid).

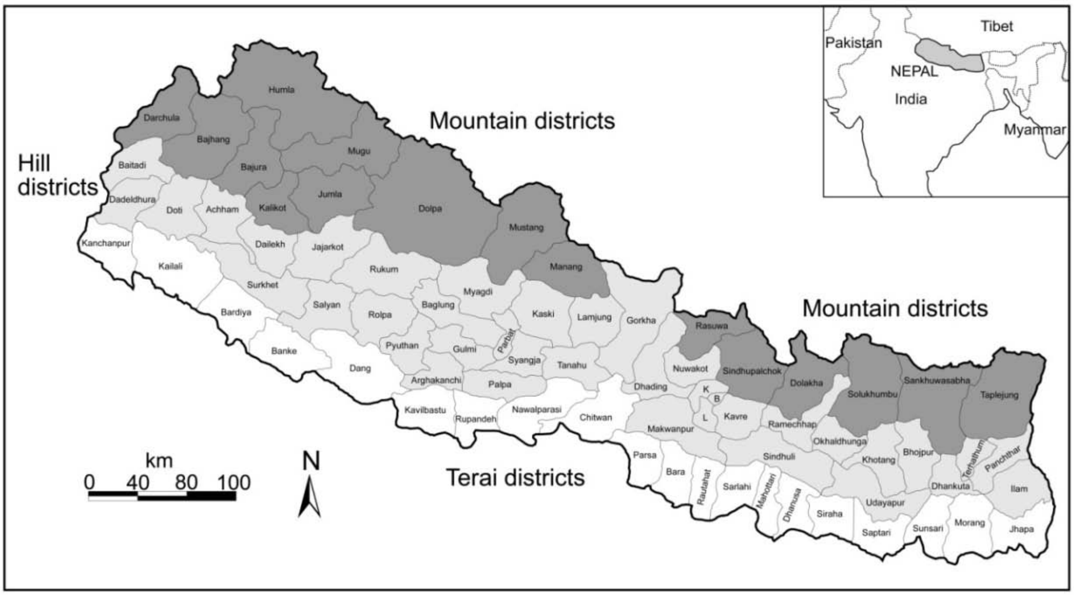


Figure 2.3 Mountain, Hill and Terai districts of Nepal. Source: Petley *et al.* (2007).

The density of fatal landslides was found to be highest in the Hill districts (Fig. 2.4) especially in the central and eastern parts of the country, along with an area of higher density in the Hill districts in the west of Nepal. This reflects a combination of relief and precipitation. The distribution correlates reasonably well with the distribution of annual precipitation totals for which the highest levels are in the Hill districts, especially in central and eastern Nepal.

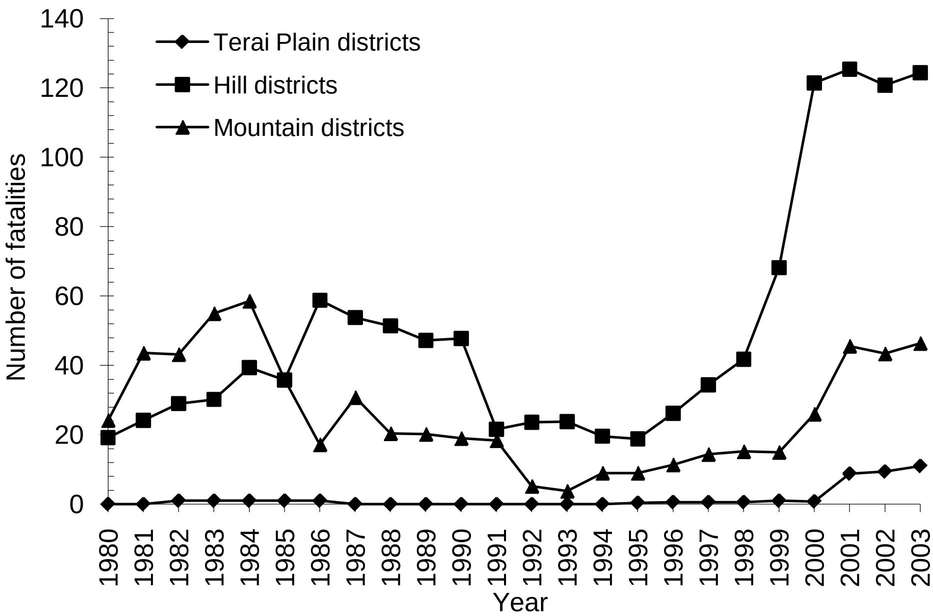


Figure 2.4 Change in the number of landslide related fatalities in the three terrain units of Nepal. The dataset has been smoothed using a five year running mean. Source: Petley *et al.* (2007).

2.4.2 Temporal trends in fatal landslide activity

The annual occurrence of landslides has been observed to depend heavily upon the character of the annual monsoon, with 92% of landslide fatalities and 90% of the recorded fatal landslide event occurring during the monsoon months of June to September. There are no recorded landslide fatalities in the period from November to April, reflecting the dry conditions which characterise these months. There is, however, considerable variation in the temporal occurrence of landslides in Nepal but with an apparent underlying cyclicity dependent upon the variability of the strength of the monsoon. Broadly speaking, the number of landside fatalities and the All India Monsoon Rainfall Index (AIMI), a widely used indicator of monsoon intensity based on precipitation intensity, show a similar but reciprocal trend (Figures 2.5 and 2.6).

The alternative index of monsoon strength, the South Asian Summer Monsoon Index (SASMI), yields similar results. In many ways this is counter intuitive as it suggests that more fatalities occur in dry years than in wet. In fact, when comparisons are made between the annual monsoon rainfall totals as recorded in the hills of Nepal and the monsoon indices, a strong, linear, negative relationship is observed. Thus, when the monsoon index is strongly positive, the total monsoon precipitation in the Hill districts of Nepal is comparatively low and vice-versa. This pattern was explained by Bookhagan *et al*. (2005) who note that the pattern of rainfall associated with the summer monsoon in the Himalayas is affected by both the regional scale atmospheric conditions and the more local scale effects of topography, most notably the interaction between rain and wind distribution.

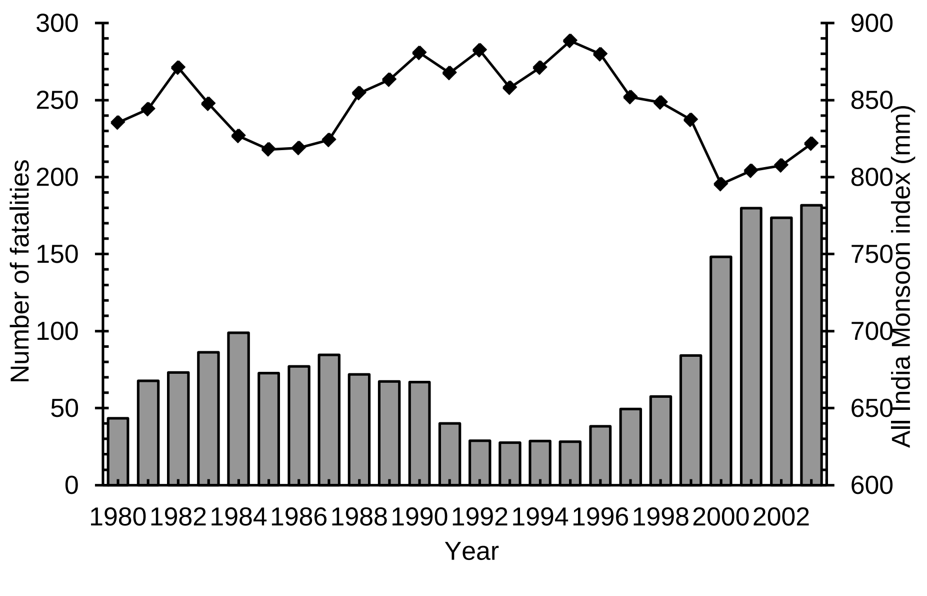


Figure 2.5 Five-year running means, indicating medium term trends, for the number of fatalities per annum (bar graph, left axis) and AIMI (line graph, right axis). Source: Petley *et al.* (2007).

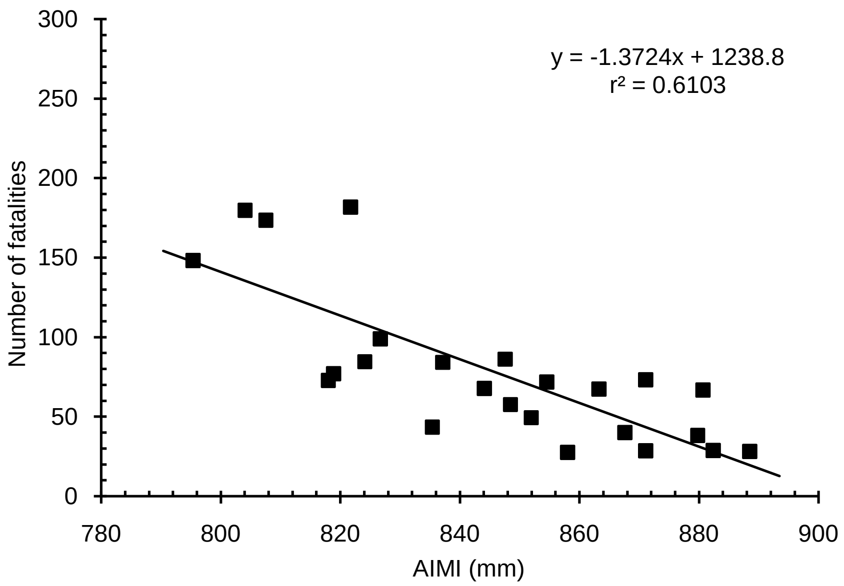


Figure 2.6 Regression between the number of landslide related fatalities per year and the AIMI, based on five year running mean data. Source: Petley *et al.* (2007).

While the monsoon appears to be the dominant driver of fatal landslide activity, in recent years the number of fatalities has increased over and above the variability of the monsoon cycle, with an abrupt transition being noted in 1995 (Fig. 2.4 and 2.5). Petley *et al.* (2007) have examined the possible causes of the observed increase in fatal landslide activity in Nepal. With the average size of events remaining largely unchanged, population growth seems an unlikely cause. Other postulated causes include deforestation, internal population displacement linked to the civil conflict and infrastructure development.

While rates of deforestation in Nepal are high, averaging 1.35% of the total forest resource per annum in 2005 (FAO 2005), they peaked in the period 1985-1990 and have subsequently declined. While a lag effect cannot be discounted, the majority of deforestation since the mid 1950s has occurred on the Terai plains while the majority of landslides have occurred in the hills. It seems unlikely, therefore, that deforestation is a major cause of the rise in landslide activity although it cannot be discounted completely.

The increase in landslide fatalities coincides with Nepal's decade long civil conflict. Petley *et al.* (2007) suggest that this is likely to have increased the vulnerability of the population due to increasing poverty and the consequent migration of people from the Maoist controlled rural areas to government controlled population centres leading to the potential growth of landslide-prone slums. While internal displacement has resulted in significant in-migration to the Kathmandu Valley (Haack and Rafter 2006) and other urban centres across Nepal, again the majority of fatal landslides have occurred in the Hill districts of Nepal. Population displacement and urbanisation therefore seem an unlikely cause.

A further explanation is the rapid increase in road construction since the early 1990s, and in particular, the construction of low technology earth or gravel roads constructed using participatory methods and with comparatively low levels of engineering input, commonly termed 'Green Roads'. As discussed in section 2.3.3, the increased occurrence of landslides along new road corridors is well documented (see, for example, Sidle *et al.* 2006). In addition, the construction of roads is likely to lead to migration and resettlement as people take advantage of the economic opportunities associated with the road (see, for example, Jacoby 2000). With the Hill districts being the main focus of road building activity in response to policy to enhance rural access, Petley *et al.* (2007) believe this is the most likely explanation for the increase in landslide activity and encourage further research into this area. Unravelling the complex relationships introduced as a result of this type of change forms a central tenet of this thesis.

2.4.3 Fatal landslide activity in Nepal since 2005

Since 2005, we have seen an increase in the number of fatal landslide events in Nepal, with 22 fatal landslide events recorded in 2006; 38 in 2007; and 49 in 2008 (ILC 2009). These events have resulted in 108, 164 and 122 fatalities, respectively (ibid). Examples include the extensive landsliding triggered by monsoon rainfall in September 2006 in the Hill districts of Far Western, Western and Central Nepal killing 44 people (NRCS 2006). Similarly, landslides were triggered by heavy monsoon rainfall in August 2007 affecting Hill and Mountain districts across Nepal, resulting in an estimated 120 deaths (NRCS 2007). 2009 looks to be another high year with more than 23 fatal landslide events recorded to date (August 2009).

2.4.4 Future landslide activity in Nepal

While a number of significant rainfall-induced disasters have been recorded, for example, the 1993 flood and debris flow disaster in southern and central Nepal which killed more than 1,160 people (160 of the fatalities were associated with landslides in upland areas) and affected more than 70,000 people, earthquakes were found to be a comparatively infrequent trigger. However, the geological structure of the Nepalese Himalaya is characterised by several east-west trending fault zones within a belt approximately 100 km wide (Wobus *et al.* 2005). These north-dipping thrust faults include: the Main Frontal Thrust, the Main Boundary Thrust, the Mahabarat Thrust and the Main Central Thrust (Berger *et al.* 2004). These branch off the Main

Himalayan Thrust which marks the under-thrusting of the Indian lithosphere beneath the Himalayas and Tibet (Zhao *et al.* 1993). Active faults along the Main Boundary Thrust and the Main Frontal Thrust are most active, and have the potential to produce large earthquakes in the future (Pandey *et al.* 1999). Research undertaken by Bilham (2001) suggests that one or more great earthquakes may be overdue across a large proportion of the Himalayan Arc. It is important, therefore, that we do not underestimate the potential impact of future earthquake activity in assessing vulnerability to landslides.

As briefly discussed in section 2.3.3, the impact of climate change on monsoon duration and intensity is not well known (Solomon *et al.* 2007). Theoretically, an increase in the temperature gradient between the ocean and the subcontinent would lengthen the monsoon season and/or increase intensities in monsoon rainfall, resulting in higher monsoon precipitation totals (Ives 2004). However, a number of studies have yielded different findings. For example, Nayava (2004) reported no substantial change in Nepal's rainfall pattern between 1971 and 2000, while early research by Zhou *et al.* (2008) suggests the South Asian monsoon has in fact weakened over the last half century. Whilst there is a strong consensus that the climate is warming, the long term behaviour of the climate system that appears to control the annual pattern of landsliding remains somewhat uncertain (Petley and Rosser in press).

Links or 'teleconnections' have been made between the occurrence of El Niño Southern Oscillation (ENSO) events and anomalies in monsoon rainfall (Kane 1998; Khole 2000; Gadgil *et al.* 2004). For example, during El Niño years, the intensity of the Indian summer monsoon rainfall is reduced (Pai 2004). It would therefore be expected that the occurrence of El Niño events would reduce the number of fatal landslide events triggered by monsoonal rainfall. A preliminary study by Petley and Rosser (in press) examining the occurrence of fatal landslides in Asia in relation to the intensity of ENSO events shows a negative correlation, with high landslide activity during La Niña conditions, and lower landslide occurrence during neutral/weak El Niño years, particularly in the South Asian region. El Niño events have become more frequent, persistent and intense during the last 20-30 years although whether this is natural or the result of anthropogenic climate change is unknown (Tudhope and Collins 2003). With studies suggesting that El Niño will strengthen slightly over the next 100 years (see, for example, Cobb *et al.* 2003) the impact on monsoon rainfall and subsequent landslide activity remains uncertain.

2.5 Summary

This chapter has outlined the mechanisms, causes and triggering factors of slope failure. Focusing on Nepal specifically, I have examined the spatial and temporal trends in fatal landslide activity between 1978 and 2005. The geophysical setting of Nepal is, unfortunately, ideally suited to creating the preparatory conditions for, and triggering mechanisms of, landslides, from a range of factors closely linked to the country's location on an active plate margin. The shifting geophysical environment of Nepal sits side-by-side with a changing landscape of social vulnerability, reflected in complex and sometimes difficult to explain trends in landslide impact. The study of these vulnerabilities is, to date, limited by the lack of experience of the full magnitude and range of events that may or could occur in Nepal. Specifically in this context, Nepal has not suffered the impacts of a high magnitude earthquake in recent history, which has both physical and social implications for subsequent years.

Whilst landslide activity is strongly controlled by monsoon intensity, in recent years the number of fatalities has increased dramatically over and above what might be expected as a result of the climatic condition alone. A number of explanations have been postulated, including population growth, land use change and the development of transport infrastructure. Of these, the most likely impacts are thought to be related to rural road development. However, to date there is little evidence to support these causes and, indeed, very little research into the nature of landslide vulnerability in the Nepalese context. It is these gaps in knowledge surrounding the interconnections between the geophysical hazard, social vulnerability and landslide risk that make the research presented in this thesis so pertinent. The chapter that follows completes the first section of the thesis by introducing the conceptual and theoretical frameworks surrounding hazard, vulnerability and risk. The further sections then begin to address the questions raised here.

Chapter 3

Framework and Theory

3.1 Introduction

This chapter focuses on the conceptual and theoretical frameworks that underpin this thesis. The key themes, 'vulnerability' and 'risk', are discussed in terms of the conceptual approaches taken within the literature and a series of working definitions for these terms are introduced. The chapter ends with a statement of the weak constructionist epistemological stance that is taken as the theoretical underpinning of this thesis.

3.2 Key definitions

Hazard is a relatively simple concept to envisage. Thywissen (2006) defines hazard as a potentially harmful event, in this case, a landslide (p.485). However, there is no single accepted definition of risk or vulnerability, indeed there is still much uncertainty about what the terms actually cover (Cardona 2004; Cutter 2006; Birkmann 2006a). This is not result of ambiguity or semantic drift, but rather disciplinary focus (Wisner 2004). In order to address this *"Babelonian Confusion"*, Thywissen (2006) has compiled a comparative glossary of core terminology used within the field of disaster research and has subsequently developed a conceptual framework based on the key characteristics of each term (Box 3.1).

Box 3.1 Core terminology and working definitions

Vulnerability	A dynamic, intrinsic feature of an element at risk (e.g. a community, household, region, state or infrastructure) that is comprised of a multitude of components. As a forward looking variable, the extent to which vulnerability is revealed is determined by the severity of the event.
Exposure	A number of people and/or other elements at risk that can be affected by a particular event.
Coping capacity	The strategies and measures that act directly upon damage during an event by alleviating or containing the impact or by bringing about efficient relief.
Risk	The probability of an event occurring.

Source: Thywissen (2006: 485-492)

In its simplest form, 'risk' can be understood as a function of hazard and vulnerability:

$$\text{Risk} = f(\text{hazard, vulnerability})$$

The sections that follow focus on the different conceptualisations of vulnerability (Section 3.3) and risk (Section 3.4).

3.3 Conceptualising and theorising vulnerability

The vulnerability discourse evolved out of the social sciences and was introduced as a response to the purely hazard-orientated approach to disaster risk that dominated disaster thinking in the 1970s (Hewitt and Burton 1971; Westgate and O'Keefe 1976; Susman *et al.* 1983). Central to the vulnerability approach is a rejection of the assumption that disasters are 'caused', in any simple way, by external natural events and that disasters are 'normal' (see, for example, Hewitt 1983a; Emel and Peet 1989). These ideas can be linked to a number of major disasters in the late 1960s/70s including the Sahel famine (1967-1973), erosion in Nepal, the Guatemalan earthquake (1976) and a hurricane affecting Honduras (1976) (Baird *et al.* 1975; Blaikie *et al.* 1977).

Viewed as the 'internal side of risk', vulnerability is an intrinsic characteristic of a system (Cardona 2004; Birkmann and Wisner 2006b) that is always there even in quiescent times between events (Thywissen 2006). Vulnerability indicates damage potential and is a forward looking variable (ibid). The conditions of the exposed element or community at risk are therefore seen as the core characteristics of vulnerability i.e. 'exposure' and 'susceptibility' (ibid). Key variables explaining variations in vulnerability therefore include: poverty level, occupation, caste, ethnicity, gender, health status, age and immigration status and the nature and extent of social networks (Wisner *et al.* 2004). From here the concept can be widened (Fig. 3.1):

- vulnerability as a *dualistic approach* with susceptibility on the one hand and difficulties in coping and recovery on the other;
- vulnerability as a *multiple structure* encompassing susceptibility, coping capacity, adaptive capacity, exposure and the interaction with perturbations and stresses;
- vulnerability as a *multi-dimensional* concept which includes physical, economic, social, environmental and institutional aspects.

(Birkmann 2006a).

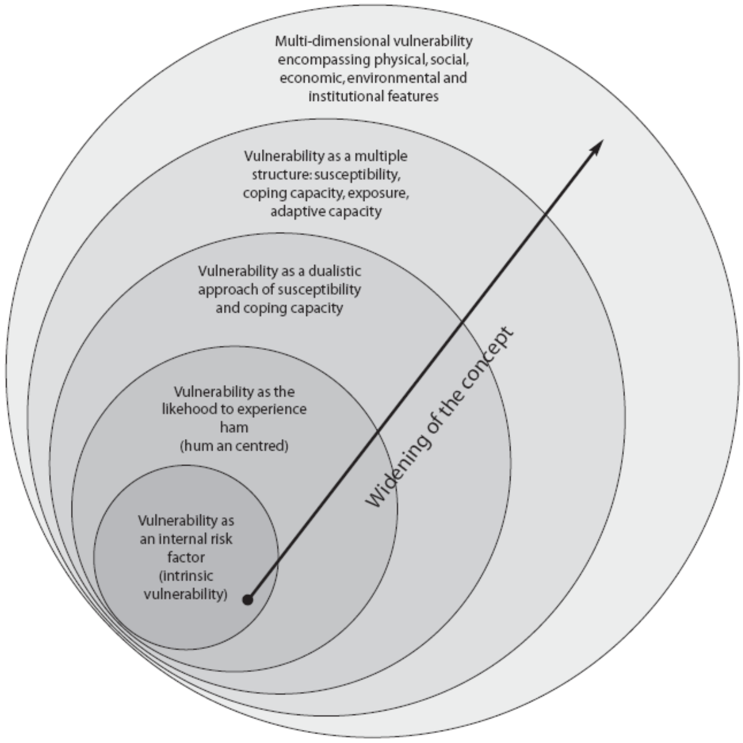


Figure 3.1 The key spheres of the concept of vulnerability (Birkmann 2006a: 17)

Cutter (2006) has identified three distinct themes in vulnerability research. These are: vulnerability as risk/hazard; vulnerability as social response; and vulnerability of places.

- **Vulnerability as a pre-existing human condition**

  The focus here is on the distribution of some hazardous condition, (in this case landslide hazard), the human occupancy of this hazardous zone and the degree of loss associated with a particular event or series of events (Burton *et al.* 1993; Anderson 2000).

- **Vulnerability as social response**

  This perspective highlights the social construction of vulnerability and its root causes, here focusing upon what makes individuals, households and communities vulnerable to landslides. Consideration is also given to the coping capacity and resilience of the exposed population (Hewitt 1997; Wisner *et al.* 2004).

- **Vulnerability as hazard of place**

  Here vulnerability is conceived as both a physical risk from the landslide hazard as well as a social response within a specific geographic domain (Kasperson *et al.* 1995; Cutter 1996).

Landslide risk assessment has largely overlooked social vulnerability and, when included, is largely based on natural science approaches (Crozier and Glade 2005). To scientists, vulnerability is essentially quantifiable. Reference is made to the degree of loss which can be expressed in terms of monetary values or an estimated number of fatalities (Glade 2003; Hufschmidt *et al.* 2005). However, while it is possible to assess the vulnerability of buildings, structures and infrastructures to a landslide of known intensity (Cardinali *et al.* 2002; Lee and Jones 2004), calculating the vulnerability of people has proven to be far more complex (Davis 2003; Lee and Jones 2004; Cutter *et al.* 2006). While attempts have been made to estimate the vulnerability of people to debris flow and hill slope failures in Australia (Fell and Hartford 1997) and to landslides in Hong Kong (Halcrow 1999), problems arise because human vulnerability is a function of a number of different factors that are difficult to quantify, including the characteristics of the landslide event, resilience, preparedness and the social conditions that prevail (Lee and Jones 2004).

As noted by Hilhorst and Bankoff (2004), understanding what makes people vulnerable is as simple as it is complex. *'At one level, the answer is a straight forward one about poverty, resource depletion and marginalisation; at another level, it is about the diversity of risks generated by the interplay between local and global processes and coping with them on a daily basis'* (p.1). Difficulties arise because investigations of vulnerability are investigations into the workings of human society, and human societies are complex and dynamic (Twigg 1998). For this reason, Twigg (ibid) argues that:

> "[v]*ulnerability is too complicated to be captured by models and frameworks. There are so many dimensions to it: economic, social, demographic, political and psychological. There are so many factors making people vulnerable: not just a range of immediate causes but – if one analyses the subject fully – a host of root causes too."* (p.6).

Wisner (2004; 2006) identifies a series of approaches to understanding and assessing vulnerability (Table 3.1.). These include the demographic, taxonomic, situational and contextual approaches.

3.3.1 Demographic and taxonomic approaches

Following a review of the social science literature, Cutter (1996) produced a summary table outlining the major factors influencing social vulnerability. These well cited 'correlates' include the individual characteristics of people, for example age, race, health, education, income, dwelling unit and social dependence. Other researchers have made similar identifications including Pelling (1997) in the context of flooding in Guyana; Morrow (1999) in the context of coastal Florida; and Velasquez and Tanhueco (2005) following a study of social vulnerability in the Philippines. GTZ (Gesellschaft für Technische Zusammenarbeit) have taken this a step further and developed a set of community-based risk indicators which include the main factors of hazard, exposure, vulnerability and capacity (Bollin and Hidajat 2006). However, assessing vulnerability in this way is very different from understanding its causes.

Table 3.1 The main approaches to assess social vulnerability

Approach	*Description*	*Limitations*
Demographic *(Structuralist)*	• People are viewed as one of many elements at risk	• People get lost in the process of conceptualising the whole system
Taxonomic *(Structuralist)*	• Vulnerability of social groups and the causes of this vulnerability • Categorise vulnerability (social, economic, environmental etc.) • Empirically developed taxonomies e.g. women/children and ethnic minorities	• Can generate too many false positives
Situational *(Structuralist)*	• Daily life and actual situation • Disasters are extensions of 'normal' or 'daily life' (household livelihood security approach)	• Recognises complexity, change and contingency – a more sensitive tool for analysis but is externally produced
Contextual *(Post-structuralist)*	• Community-based vulnerability assessment • Community defines its own vulnerabilities and capabilities; which risks are acceptable and which are not	• Limitations of local knowledge • Uncertainty associated with climate change

Adapted from: Wisner (2004; 2006).

3.3.2 Situational and contextual approaches

In the late 1980s and early 1990s, a number of conceptual and theoretical models were developed with the aim of understanding what vulnerability is and the factors that cause it. These include the 'Pressure and Release' and 'Access' models produced by Blaikie, Cannon, Davies and Wisner (1994) and advanced by Wisner *et al.* (2004). Such models view disasters as an extension of normal or daily life.

The Pressure and Release (PAR) model is based on the acknowledgement that a disaster is the result of two opposing forces: the forces generating vulnerability on one side and the physical exposure to hazard on the other (Twigg 2001). The model proposes a progression of vulnerability with three main levels (Figure 3.2):

1. *Root causes* are the most remote influences. They are economic, demographic and political processes within society including global processes. They reflect the

distribution of power within a society, and are connected to the functioning and power of the state.

2. *Dynamic pressures* channel the root causes into particular forms of insecurity that have to be considered in relation to the types of hazards facing vulnerable people. These include reduced access to resources as a result of the way regional or global pressures work through to localities.
3. *Unsafe conditions* are the specific forms in which a population's vulnerability is expressed in time and space in conjunction with a hazard. Examples include people having to live in dangerous locations, being unable to afford safe buildings, having to engage in dangerous livelihoods or having minimal food entitlements.

All of these factors change over time, sometimes rapidly. They also interact with each other in complex ways and the outcome can be unpredictable.

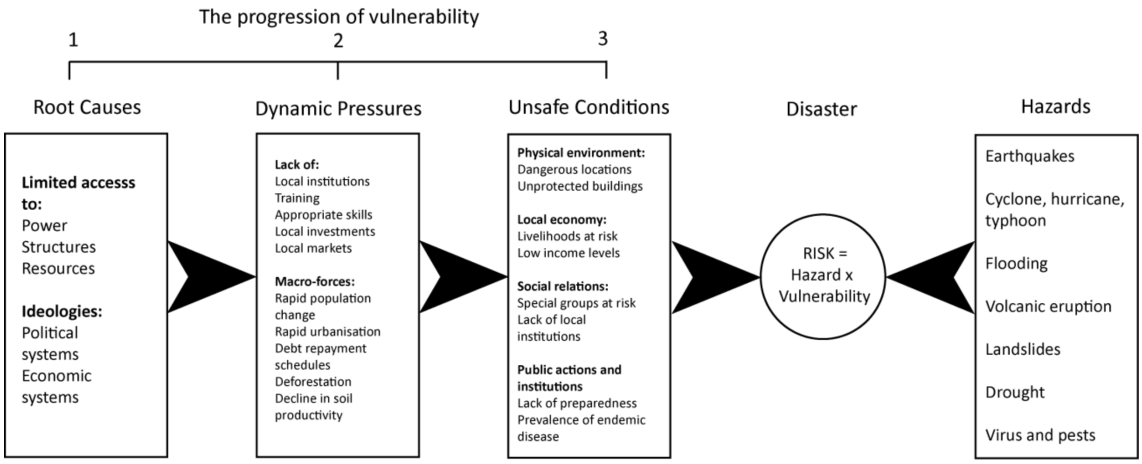


Figure 3.2 Pressure and Release (PAR) model: the progression of vulnerability (Wisner *et al.* 2004: 51)

While the PAR model focuses upon the progression of vulnerability, the Access model explores what happens at the pressure point between the 'natural' event and the longer term social processes (Fig. 3.3). Central to the Access model is a description of 'normal' life before a disaster and the 'access' that individuals, households and communities have to the capabilities and livelihoods opportunities that will enable them to reduce their vulnerability and build their resilience (Wisner *et al.* 2004). For the purposes of this research, Ellis' (1999) definition of livelihood will be used: *'The activities, the assets, and the access that jointly determine the living gained by an individual or by a household'* (p.2).

Taking the household as the basic unit of analysis, emphasis is placed on a household's initial 'state of well-being'; their physical ability to withstand shocks and prolonged periods of stress. Each household has access to resources which may include land, livestock, reserves of food, labour power and skills. Non-material resources are also essential, for example, the structural position occupied in a society such as membership of a particular hill tribe or caste group, which can facilitate or prevent access to resources and access to networks or support. Households make choices, within constraints, to take up one or more livelihoods or income opportunities, for example growing different crops, petty trade or day wage labour. This is dependent upon access qualifications required in order to take up an income opportunity, for example, skills, caste or gender. Some households have more choices in securing a livelihood than others. For example, households with limited access profiles usually have little choice in income opportunities and have to seek the most over-subscribed and lowest paid options and therefore have the least flexibility during adverse conditions. This influences their survival strategies and coping mechanisms. Wisner *et al.* (2004) acknowledge that the Access model is a largely mechanistic and economistic treatment of access to resources and that it is necessary to embed this model in the political economy at household level and beyond. For example, gender politics at the household level, relations between classes and groups across society and the impact of the wider market economy

The Access model goes on to map the processes by which normal life becomes abnormal in the case of shocks or stresses. As summarised by Wisner *et al.* (2004), working through the model (Fig. 3.3), hazards (3) have specific time/space characteristics (4) which can result in a 'trigger event' (5) for example, a landslide. Households earn their livelihoods in normal times (1), and are subject to unsafe conditions (2) and the political economy in which they live is shaped by social relations and structures of domination (1a and 1b). The heavy black arrow in Fig. 3.3 shows a hazardous event bursting through the layer of social protection (which can be individual, collective or public e.g. building regulations, emergency funds etc.), impacting each household differently (6). Subsequent iterations of unfolding impacts and human responses occur through time (7). This leads to 8 which represents altered conditions of vulnerability, social protection and actions for preventing future disasters (Wisner *et al.* 2004: 89-90).

While the models have received some criticism, for example, for their overly economistic, structuralist approach; for not linking political and socio-economic processes well enough; and for underestimating human agency (see, for example, Haghebaert 2001), they offer a useful starting point for understanding social vulnerability.

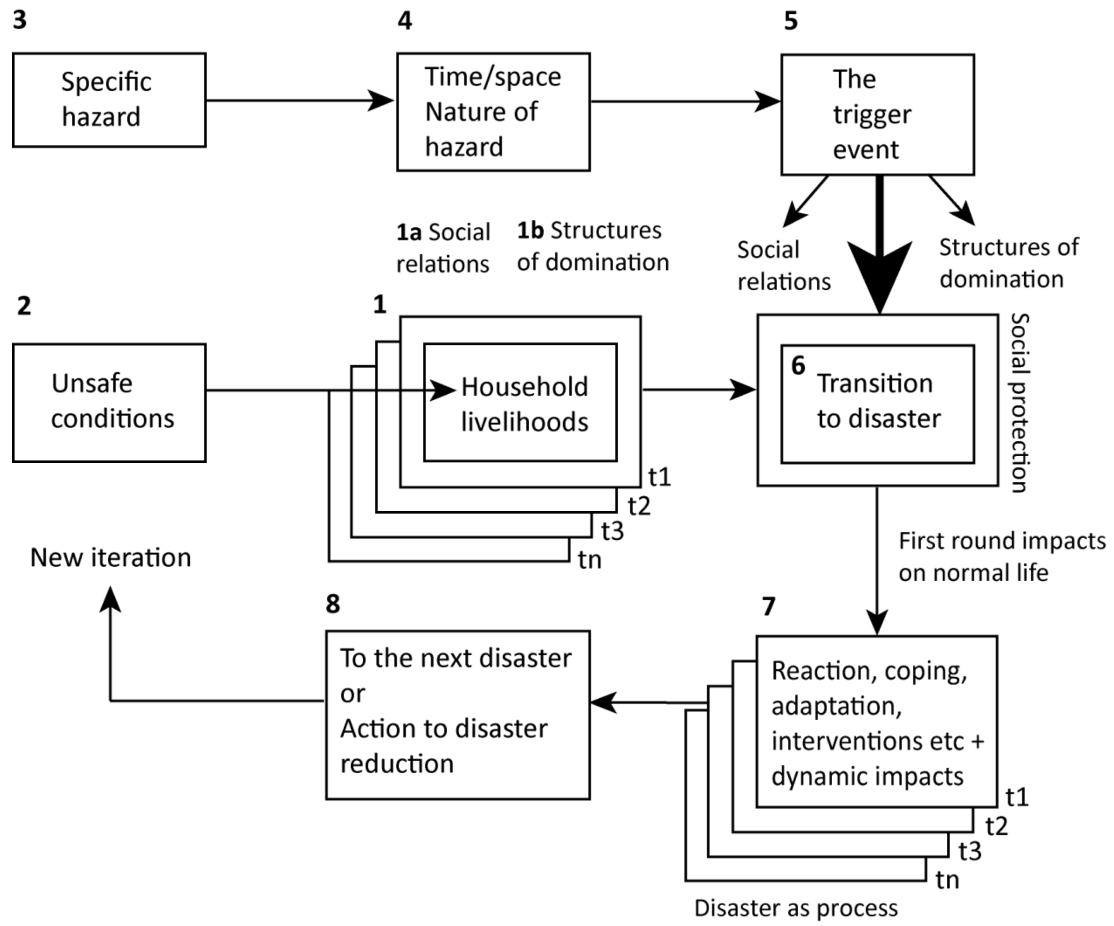


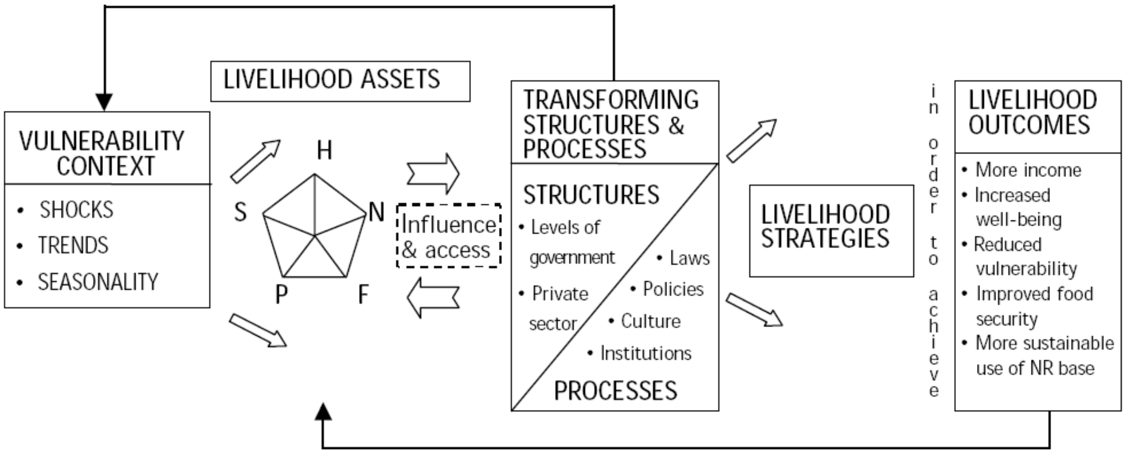
Figure 3.3 The Access model (Wisner *et al.* 2004: 89)

Sustainable livelihoods

There are many links between the Access model and the 'sustainable livelihoods' approach to development. While the sustainable livelihoods approach was not developed specifically for the analysis of disasters, the framework views people as operating in a context of vulnerability, with livelihoods exposed to shocks and stresses (Chambers and Conway 1992; Ashley and Carney 1999). Figure 3.4 provides a schematic outline of the sustainable livelihoods framework. Working through Figure 3.4 from right to left, households and individuals pursue certain livelihood strategies and these are filtered through political and institutional structures and draw on a pentagon of livelihood assets which are associated with five types of capital or livelihood building blocks – human, natural, physical, social and financial. How these assets are deployed is linked to the types, frequency (periodicities) and intensities (severity) of vulnerabilities and shocks that households and individuals face. The framework presents three different types of vulnerability:

- *Trends* are usually long-term and large-scale. They include population trends, resource trends (including conflict over resources), economic trends (national and international), trends in governance and politics, and technological trends. They have a particularly important influence on rates of return from chosen livelihood strategies.

- *Shocks* include human health shocks (e.g. epidemics), natural shocks (e.g. natural hazard-induced disasters), economic shocks (e.g. rapid changes in exchange rates), conflict and crop/livestock health shocks. They can also force people to dispose of assets as part of coping strategies. Resilience to external shocks and stresses is an important factor in livelihood sustainability.
- *Seasonality* is expressed through seasonal shifts in prices, production, food availability, employment opportunities and health. These are one of the greatest and most enduring sources of hardship for poor people.



H = Human capital **N** = Natural capital **F** = Financial capital **S** = Social capital **P** = Physical capital

Figure 3.4 Sustainable livelihoods framework (Ashley and Carney 1999).

The core principles of sustainable livelihood approaches are: a focus on people and communities rather than on structures and the national context; a concern with seeing livelihoods in holistic terms crossing sectors, spaces, actors and institutions; and a commitment to identifying the macro-micro linkages that are salient to understanding livelihood (Rigg 2007: 32). However, like the Access model, the sustainable livelihoods framework has been criticised for its overly mechanistic view of livelihoods. As summarised by Rigg (2007), it is also necessary to consider the social and non-material aspects of work and living for example, preferences and aspirations which contribute to well-being. These factors are often harder to assess but are just as important in explaining the decisions and choices they make (see, for example, de Haan and Zoomers 2005; Gough *et al.* 2007). It is also necessary to consider the dynamic nature of the household, and as Rigg (ibid) notes '*we need to appreciate not just how households and individuals sustain their existing pattern of living -*

often reflected in the tendency to write in favourable terms of livelihood 'resilience' – but how (and why) the bases of livelihoods change over time' (p.34).

3.3.3 My approach

As set out on Chapter 1, this thesis takes a livelihoods based approach to understanding vulnerability to landslides in the Nepal Himalaya. For this, the PAR, Access and Sustainable Livelihoods models provide useful conceptual frameworks. They are in no way followed rigidly; indeed I am far less mechanistic in my approach and take on board the critiques outlined above, but they do provide a useful starting point for my analyses. Instead, I take a largely situational and contextual approach to understanding vulnerability. Grounded in the root causes of vulnerability, emphasis is placed on the everyday – on 'normal' living in Central Nepal - in an attempt to understand who occupies landslide prone areas and why.

3.4 Risk

The second conceptual and theoretical framework central to this thesis is risk. At a generic level, risk can be broadly defined as *'the potential for adverse consequences, loss, harm or detriment or the chance of loss'* (Lee and Jones 2004). Within the literature, two dominant themes can be distinguished: a quantitative, technical view of risk and a broad socio-cultural perspective (Hewitt 1997).

3.4.1 The technico-scientific approach

The modernist technico-scientific notion of risk emerged from the fields of engineering, statistics, psychology, epidemiology and economics (Lupton 1999a; 1999b). Concerned with the probability of the occurrence of a specific hazard (Royal Society 1992), risk seeks to estimate the probability of certain measurable (adverse) outcome in a specific system or population, such as the number of deaths, injuries or monetary loss over time and space (Hewitt 1997) for example in the form of landslide risk assessment (Petley and Hearn 2003; Bell and Glade 2004). Several models of risk assessment exist which, broadly speaking, involve hazard identification; the estimation of magnitude and frequency/probability of hazards; identification of consequences; estimation of the magnitude of consequences; and estimation of frequency/probability of consequences (Lee and Jones 2004). However, while this natural science approach has undoubtedly contributed to the knowledge of one main component of risk – the hazard (Cardona 2004) – it can be argued that the approach fails to problematise risk and its assessment (Lupton 1999b).

3.4.2 The socio-cultural perspective

By comparison, socio-cultural perspectives on risk place emphasis on the social and cultural contexts in which risk is understood and negotiated (Lupton 1999a). Emerging from disciplines including cultural anthropology, philosophy, sociology, geography, and science-technology studies, the writings are distributed along a continuum of epistemological positions (Stallings 1997). Moving across the continuum, Wisner *et al.* (2004) identify these as realist, weak constructionist and strong constructionist. Realists are typified as being *'empirically grounded but sociologically unaware'* (Forsyth 2003: 14). Broadly speaking they take a technocratic approach to risk where the environment is considered external to society and capable of being measured objectively much like the natural science approach (Lupton 1999b). By comparison, constructionist may be characterised as *'relativist and postmodern'* (Forsyth 2003: 14) and are concerned with the social and cultural aspects of risk. To weak constructionists risks are based on objective facts that are mediated through social, cultural and political processes (Oliver-Smith and Hoffman 1999), while strong constructionists move beyond this and consider nothing to be a risk in itself with both hazards and risks being socially constructed (Macnaghten and Urry 1998; Lupton 1999a). Table 3.2 outlines this continuum of epistemological approaches to risk within the social sciences and provides a critique of the key theoretical perspectives.

Set within this broad epistemological framework, a number of theoretical perspectives on risk have emerged (Lupton 1999b) including the 'cultural/symbolic' (Douglas and Wildavsky 1982; Douglas 1985; 1992; 1996) and the 'risk society' (Giddens 1990; Beck 1992) perspectives. The 'cultural/symbolic' theorists focus their analyses on risk perception and in relation to culture. What is considered a risk and, and how serious that risk is thought to be, is seen to vary depending upon the organisation or group to which a person belongs, or with which they identify, along with the disasters, accidents or other negative occurrences (Douglas 1992). Douglas's notion of risk is therefore useful when attempting to understand how landslide hazards/risks are identified, perceived and understood.

Beck's 'Risk Society: Towards a New Modernity' (1992) is concerned with the proliferation of risks as a consequence of technical innovation that has got out of control (Fox 1999) and in this sense his work is quite remote from the dynamics of hazard, vulnerability and risk in less developed countries. As summarised by Leach and Scoones (2005) perspectives from development studies suggest that works in the contemporary risk society tradition overstate the novelty of the risks faced by late industrial society. Risks, hazards, and uncertainties have

Table 3.2 Theorizing risk: the social science perspective

Theoretical perspective[1]	*Associated perspectives/theories*	*Opportunities*	*Constraints*
Realist *Risks are directly related to the hazard* • Based upon scientific measurement and calculation • Risks are calculated objectively and can be measured independently of social and cultural processes	• Technical/scientific approaches to risk • The 'risk society' approach (Beck 1992)	• Risk assessment and risk management with the aim of risk reduction	• The socio-cultural aspect of environmental problems are ignored (Dunlap and Catton 1994)
Weak constructionist *Hazards are natural, risks are cultural* • Recognition of the social and cultural aspects of risk • Risk is calculated based on objective facts about hazards which are mediated, perceived and responded to via social, cultural and political processes	• The 'Risk Society' approach – risks only exist in terms of the knowledge about them and are open to social definition and construction (Beck 1992)	• Sociologically informed risk assessments which overcome the naiveté of the technical scientific evaluation (Fox 1999) • Useful when determining how social and cultural factors influence how people interpret and make sense of risk (Bickerstaff 2004)	• Realist critiques are largely aimed at radical or extreme social constructionism (see below)
Strong constructionist/Postmodernist *Risk perceptions fabricate hazards* • Hazards themselves (along with risks) are socially constructed – a product of historically, socially and politically contingent ways of seeing • What is deemed a 'hazard' in one historical or cultural context may not be so in another	• The 'cultural/symbolic' approach (Douglas 1992)		• No acknowledgement of the independent existence of nature or environmental problems (Burningham and Cooper 1999) • Morally/ethically wrong? (Dunlap and Catton 1994) • Social constructionism gone overboard (Murphy 1994)

[1] Adapted from Fox (1999); Lupton (1999a; 1999b)

long been experienced in developing country settings in the constant interplay of ecological and bodily processes, capricious markets, government politics and international engagements (p.20). For this reason, I acknowledge the work of Beck but do not engage directly with it.

3.4.3 My approach

Landslides in Nepal pose a very real, and to a certain extent quantifiable, risk to society. However, as noted by Dunlap and Catton (1994) there are socio-cultural aspects to environmental problems ignored by realists but which are worthy of consideration. People experience landslide hazard in diverse, multi-faceted and complex ways (Macnaghten and Urry 1998). Therefore, whilst I reject the strong constructionist approach to understanding risk, adopting a weak constructionist approach will help to overcome the naïveté of technical/scientific evaluations (Fox 1999).

Section 1 has highlighted the complexity associated with understanding patterns of social landslide vulnerability to landslides in Nepal. The following section (Section 2), introduces the methodological approaches adopted. It then integrates literature sources with contemporary field data collected within this thesis to determine the geophysical and social vulnerability context for the six case study settlements in the Upper Bhote Koshi Valley.

Chapter 4

Geomorphological Context

4.1 Introduction

This chapter provides an introduction to the study area and the six case study settlements that are examined in detail in this thesis. The chapter first presents an overview of the geological and geomorphological characteristics, and then analyses the distribution of settlements within the Upper Bhote Koshi Valley. Each case study settlement is then introduced, with particular emphasis on the geomorphological setting and the local occurrence of landslide hazard. A series of geomorphological maps based on field mapping and the interpretation of aerial photographs and satellite imagery are presented and discussed as the basis for establishing the landslide hazard in each location. The field mapping was undertaken over a period of three weeks, with field visits in November 2006 and June 2007.

4.2 Geological and geomorphological setting

The empirical research for the thesis was conducted in the Upper Bhote Koshi Valley, Sindhupalchok District, in the Central Development Region of Nepal, approximately 100 km north east of the Nepalese capital, Kathmandu (Fig. 4.1). The catchment feeds the Bhote Koshi River, which forms the pass followed by the Arniko Highway linking Kathmandu and China (Tibet), passing through the main trading towns of Barabise and Kodari in Nepal. The valley is located north east of the district headquarters of Chautara and administratively can be divided into ten Village Development Committees (VDCs) (Fig. 4.2). The Upper Bhote Koshi Valley is settled predominantly by hill ethnic Tamang and Sherpa peoples of Tibeto-Burmese origin interspersed with caste Hindus including the high caste Chhetri and Newar peoples, and the occupational caste Kami or blacksmiths (Fig. 4.2).

The rainfall pattern in the Bhote Koshi river basin is governed mainly by a monsoon climate. The valley receives between 2500 and 3000 mm of rainfall per year, 71-92% of which is concentrated in a four month period between June and September (Adhikari and Koshimizu 2005). This, combined with high elevations of up to 4,000 m asl and high local relief, makes the area highly susceptible to weathering and erosional processes. Geologically, the Upper Bhote Koshi Valley is characterised by a complex tectonic sequence of steeply dipping phyllite,

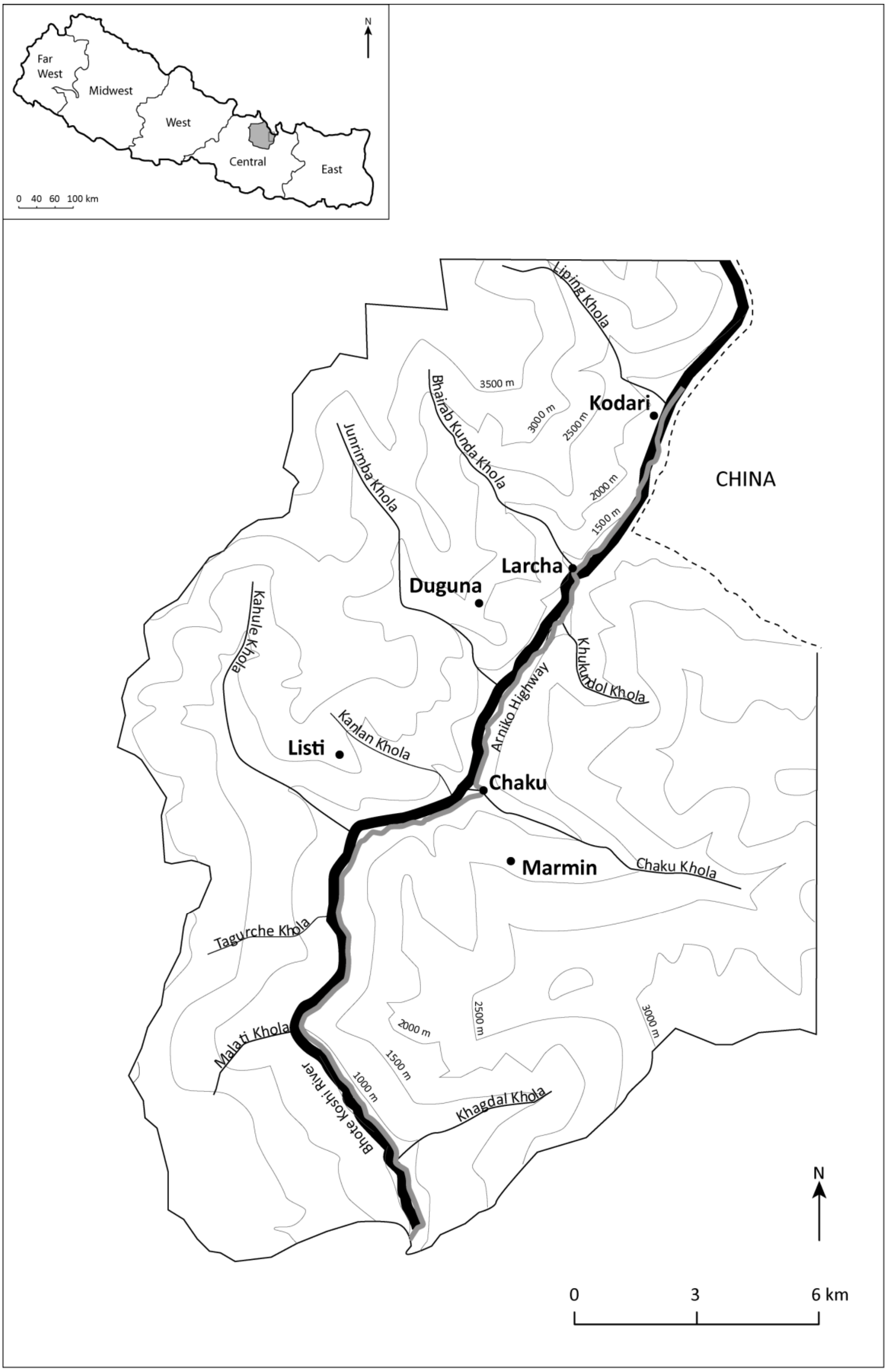


Figure 4.1 The Upper Bhote Koshi Valley, Sindhupalchok District. Inset is a thumbnail showing the location of the study area in Central Nepal. Adapted from a 1:50,000 digital topographic map of the study area (Department of Survey 2000).

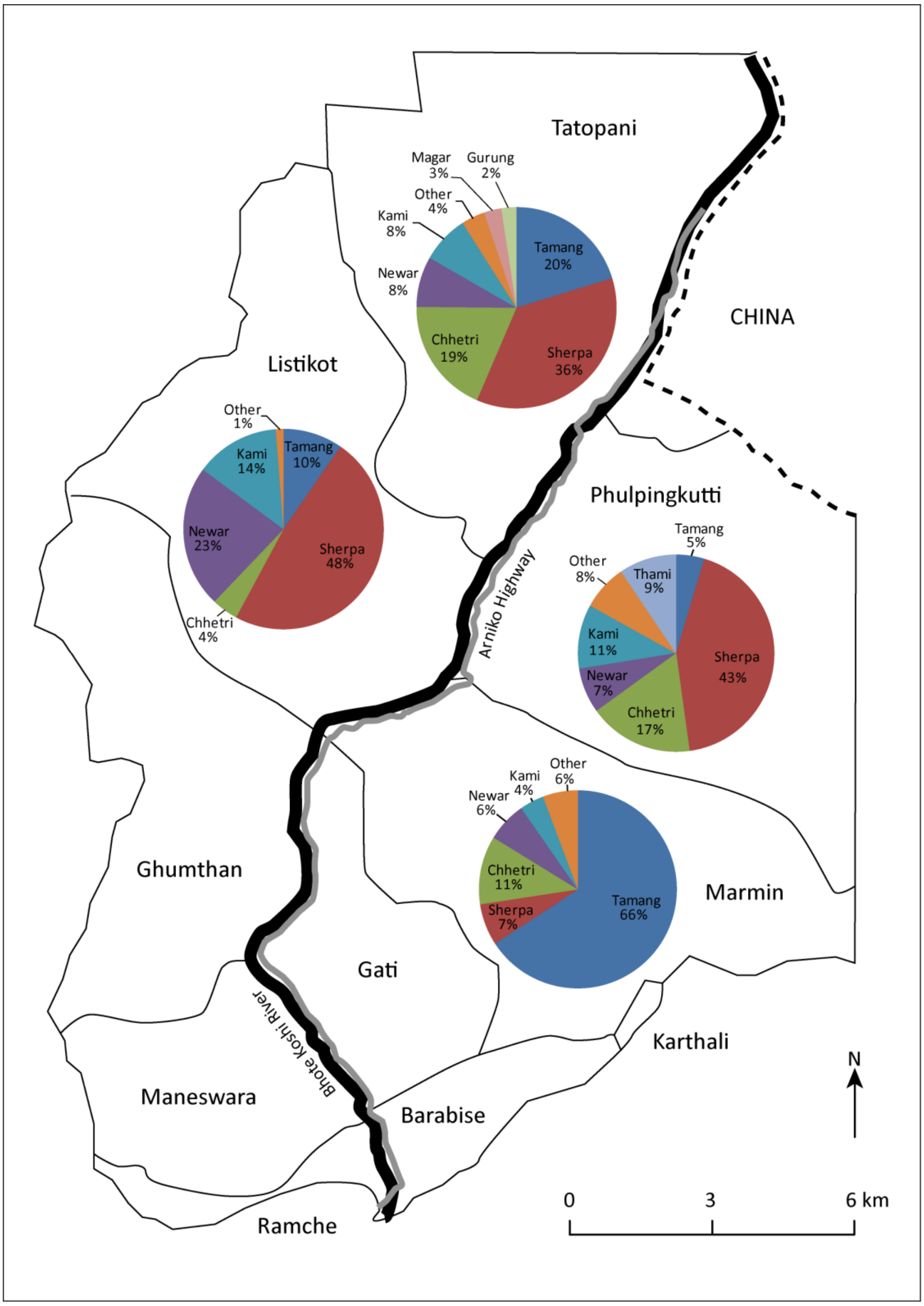


Figure 4.2 An administrative map of the Upper Bhote Koshi Valley showing the four case study VDCs including the population break-down. Adapted from a 1:50,000 digital topographic map of the study area (Department of Survey 2000). Population data were sourced from the 2001 Nepal Census (CBS 2002).

schist, gneiss, limestone and quartzite formations overlaid with highly weathered colluvial and alluvial deposits (Fig. 4.3). In the Himalaya, phyllite rocks have been found to be the most susceptible to landsliding followed by shales, schists, poorly cemented sandstone, limestones, gneiss, granites and quartzite (Gerrard 1994). In the Upper Bhote Koshi Valley extensive gully erosion is common in the deeply weathered regolith. Rock falls frequently occur from steep phyllite cliffs, their location being governed by the pattern of discontinuities in the rock mass. Large, creeping, deep-seated translational slides are common, while rotational slides are largely confined to those areas where deeply weathered schists are undercut by rivers or gullies. Channelised debris flow hazards also occur along deeply incised tributaries. The narrow valleys require relatively small volumes of material to dam the channels.

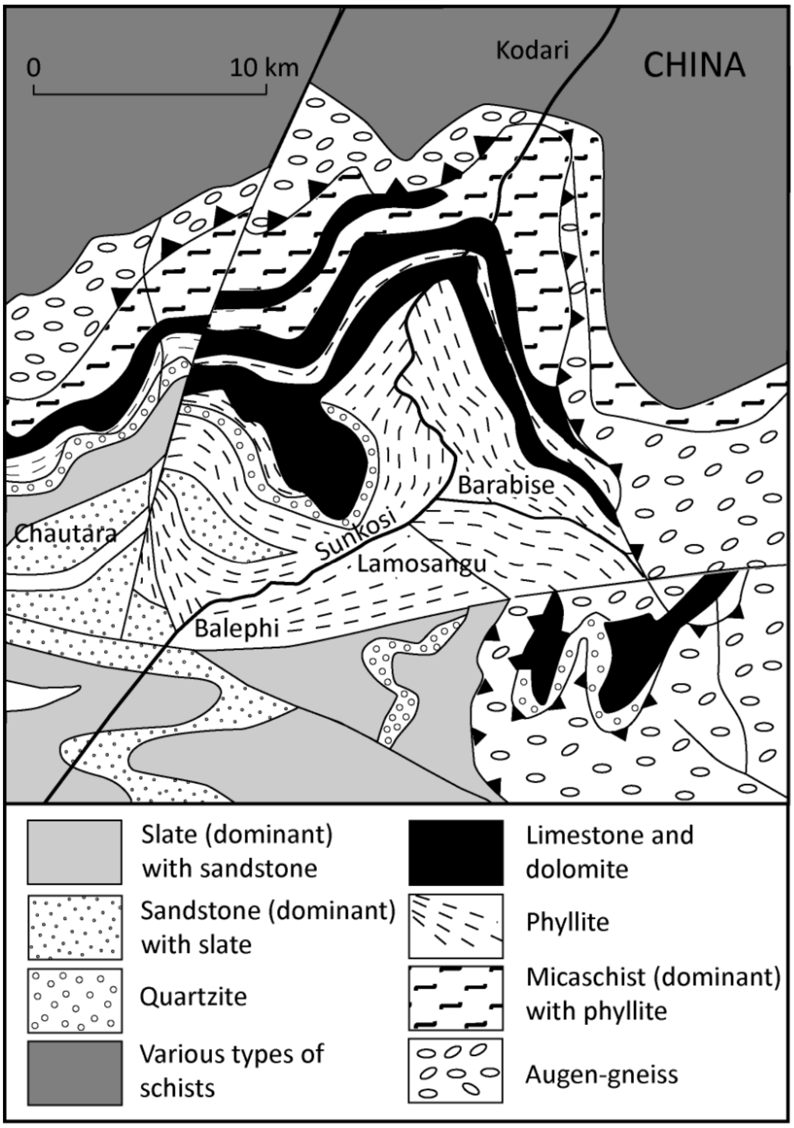


Figure 4.3 Geological map of the Bhote Koshi catchment. Adapted from: SDC (1997).

The Main Central Thrust (MCT) zone, one of the three major boundary faults for the Himalaya which marks the boundary between the Lesser and Higher Himalaya (Wobus *et al.* 2005), traverses the valley at the settlement of Tatopani. The MCT dips north placing high-grade metamorphic rocks of the Greater Himalaya over unmetamorphosed rocks of the Lesser Himalaya (Searle *et al.* 2008). This broad zone of disturbance is characterised by highly fractured material, with high susceptibility to rock falls and landslides. While the MCT is seismically active, it is of secondary importance in terms of seismic hazard to the Main Boundary Thrust (MBT) and the Main Frontal Thrust (MFT) (Pandey *et al.* 1999).

There has been extensive debate regarding the role of glaciers and mass wasting processes in shaping high valleys of the Himalaya in general (see, for example, Owen *et al.* 1998; Fort 2000) and the Upper Bhote Koshi Valley specifically (SDC 1997). A study undertaken by the SDC (1997) identified three glacial stages in the Upper Bhote Koshi Valley: the Barabise, Lamosangu and Balephi stages dated at 500,000, 300,000 and 50,000 years BP respectively. Geomorphologically, however, there are few identifiable glacial valley attributes. The valley, for example, is V–shaped rather than U-shaped, and preserved moraines are difficult to identify. Fort (2000) argues that much of the colluvium observed in the high valleys of the Himalaya today is best interpreted as the product of landslides and debris flows rather than glacial activity, although some reworking of glacial deposits is likely. While the glacial history remains uncertain, mass wasting is the dominant process influencing the evolution of the current landscape and dominates the active veneer of the landscape upon which communities have developed.

There are currently six glacial lakes situated within the Bhote Koshi catchment, mirrored by clear glacial lake outburst flood (GLOF) deposits within the present river channel and valley bottom. Significant GLOF events were recorded in 1964 and 1981, the latter event transporting an estimated 4 million m^3 of material with a flood discharge in Barabise of 2150-3300 m^3/s (SDC 1997). GLOFs have been identified as a trigger and conditioner for subsequent landslide activity within the Upper Bhote Koshi Valley through undercutting and incision. Examples include the 1981 Kodari landslide (see section 4.5.1).

4.3 Settlement distribution and land use in the Upper Bhote Koshi Valley

The following analysis is based on 1:50,000 digital topographical data compiled from 1992 aerial photographs (Department of Survey 2000) and analysed using a geographical information system (GIS). This is the most recent topographic data available for the study area.

4.3.1 Settlement distribution

A digital elevation model (DEM) has been generated by interpolating 1:50,000 contour data (Department of Survey 2000) using a kriging algorithm in ENVI 4.0, and from the resulting topography slope angle and aspect were calculated (Figs. 4.4, 4.5 and 4.6). To ease data handling a 1% random subsample of each of the three variables (altitude, slope angle and aspect) was extracted and the distributions of these characteristics are displayed using probability density functions (Figs. 4.7, 4.8 and 4.9). To analyse the distribution of settlements in relation to altitude, slope angle and aspect across the Upper Bhote Koshi Valley, the spatial analyst function in ArcGIS was used to extract the topographic attributes for each settlement cluster. As before, these values were displayed using probability density functions to explore the choices made in settlement location relative to the wider landscape characteristics. Whilst this is a very mechanical way of exploring the links between the natural and social environment, it offers some interesting insights which will be explored in greater detail in Chapter 6.

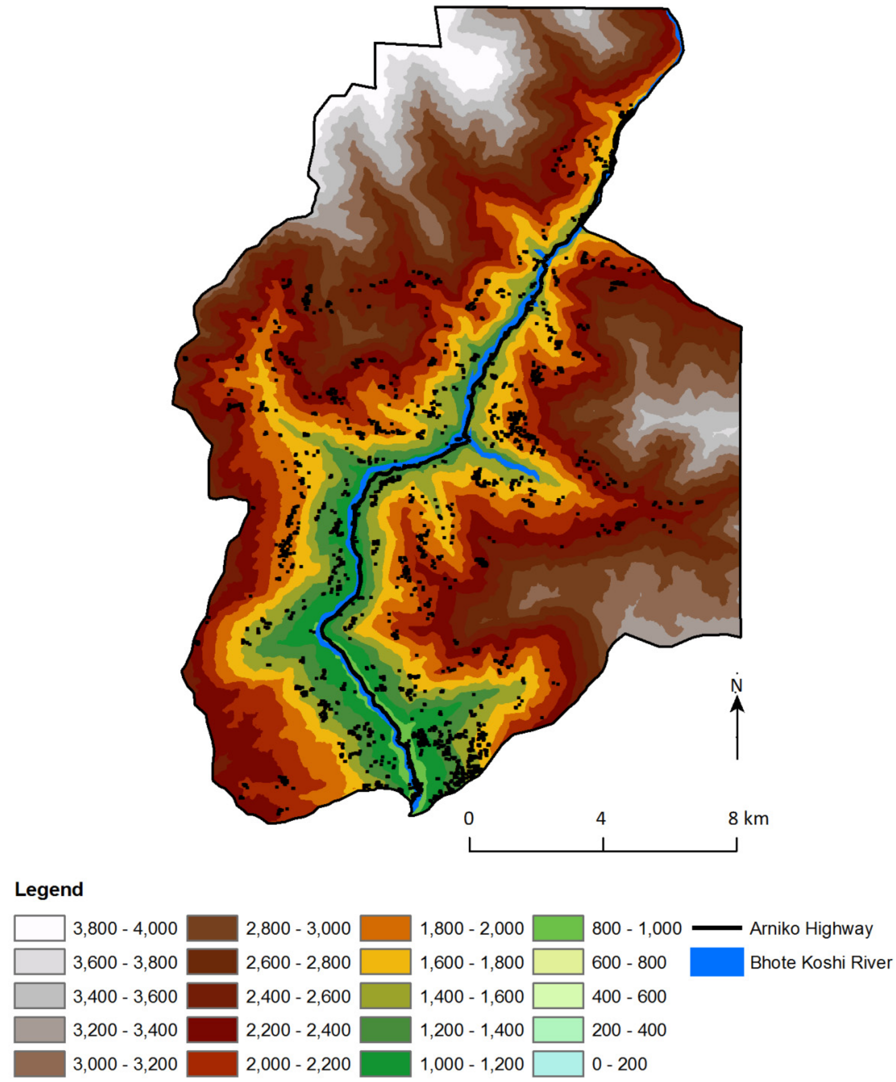


Figure 4.4 Settlement distribution (black squares) across the Upper Bhote Koshi Valley in relation to elevation.

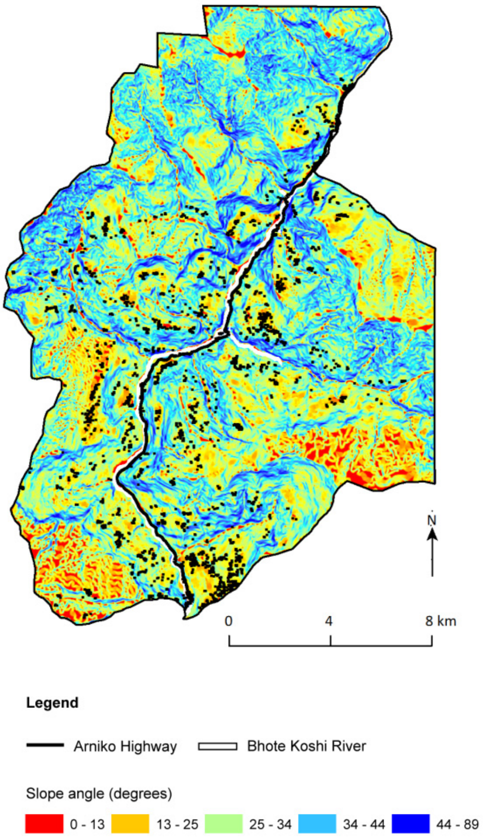


Figure 4.5 Settlement distribution (black squares) across the Upper Bhote Koshi Valley in relation to slope angle.

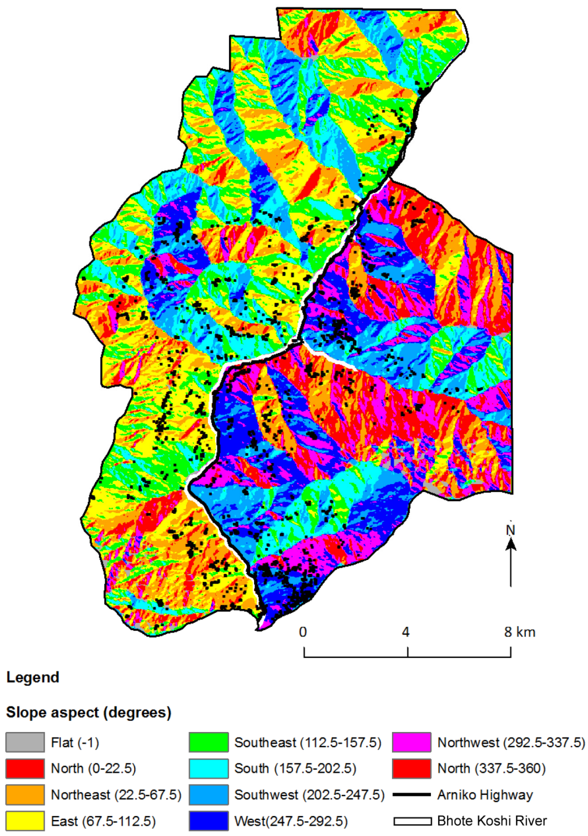


Figure 4.6 Settlement distribution (black squares) across the Upper Bhote Valley in relation to aspect.

Elevation

Elevation within the study area in the Upper Bhote Koshi ranges from 800 m to 4,000 m asl (Fig. 4.7). 50% of slopes lie between 2,000 and 3,000 m asl, with only 16% above 3,000 m asl.

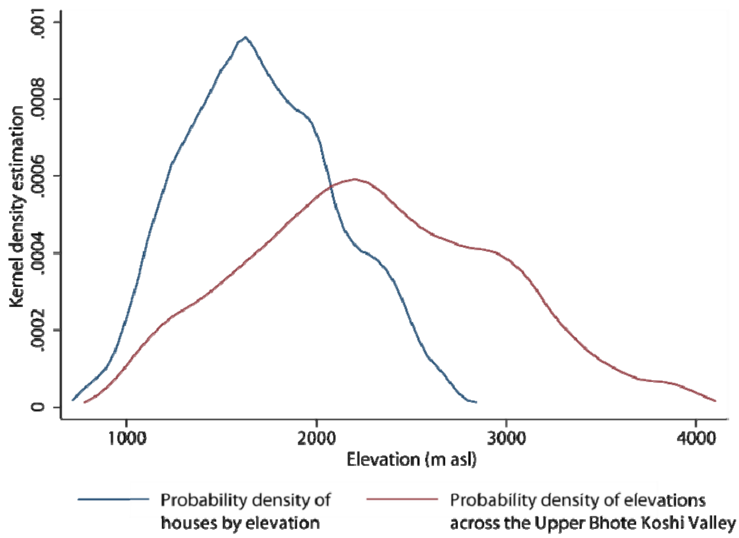


Figure 4.7 The probability density of elevations across the Upper Bhote Koshi Valley and houses by elevation.

These data suggest that 74% of settlements are located between 1,000 and 2,000 m altitude, 44% of which are located between 1,500 and 2,000 m asl. 74% of settlements therefore occupy just 33% of the slopes within the Upper Bhote Koshi Valley. Although the valley base level rises through the study area, this demonstrates that the population is distributed across a relatively wide range of elevations, below 3000 m. Interestingly this distribution suggests that there is not a bimodal distribution of valley top and valley bottom locations, but a more even distribution up the valley side slopes.

Slope angle

The analysis suggests that 80% of slopes are less than 40 degrees, with 81% of settlements located on slopes less than 30 degrees (Figs. 4.8). 51% of settlements are located on slopes between 15 and 25 degrees. The location of settlements relative to slope angle reflects the ease with which the ground surface can be developed for construction and agriculture. The location relative to potentially unstable slopes, such as directly beneath steep cliffs, remains more complex to identify, yet the data suggest again a generally dispersed population relative to slope angle, rather than specific preferences.

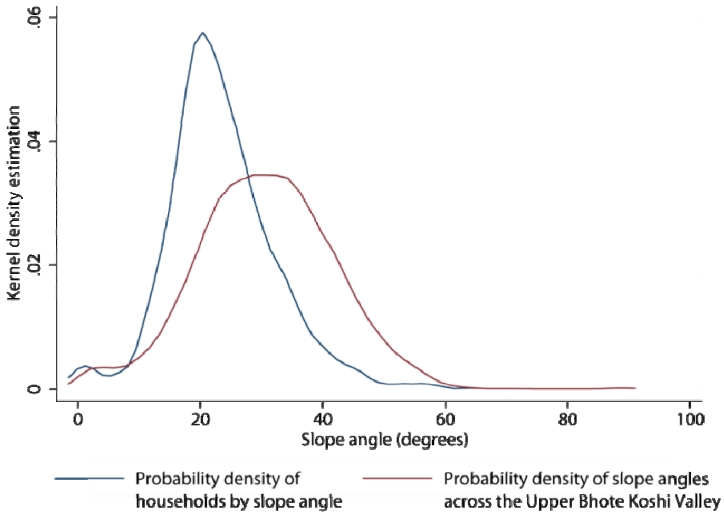


Figure 4.8 The probability density of slope angles across the Upper Bhote Koshi Valley and houses by slope angle.

Aspect

Settlements are located across all mountain slopes but the mean aspect is south west-facing (Fig. 4.9) favoured for settlement and agriculture. However, the vector strength is not significant enough to assume a statistically valid correlation between slope aspect and settlement distribution within the Upper Bhote Koshi Valley. Again, this distribution probably reflects a limited degree of significance of aspect combined with a relatively restricted choice in location relative to aspect, defined by the valley structure of the study area.

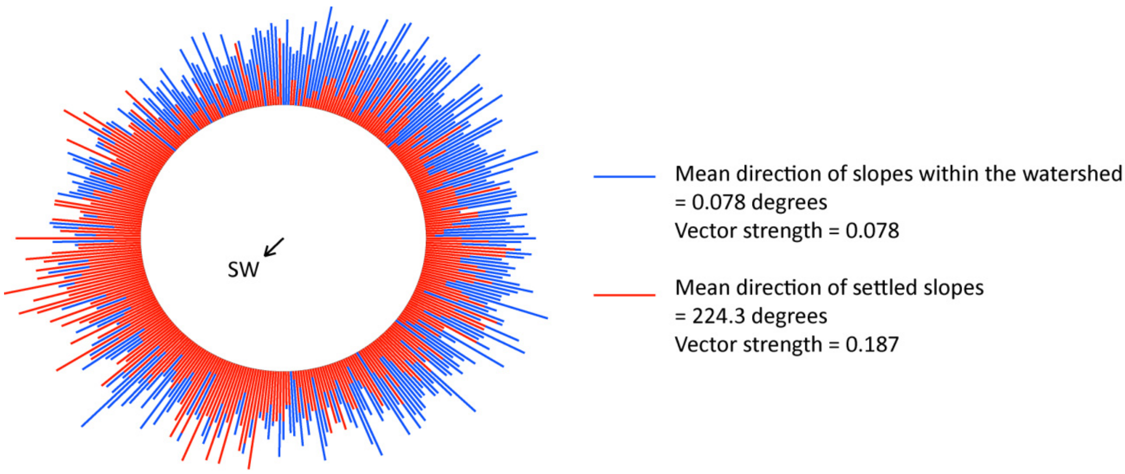


Figure 4.9 Mean slope aspect across the Upper Bhote Koshi Valley and the mean aspect of occupied slopes.

4.3.2 Land use

The various land use types in the Upper Bhote Koshi Valley are shown in Table 4.1. The areas under the respective land uses have been obtained from the analysis of digital topographic data compiled from 1992 aerial photographs (Department of Survey 2000). The Upper Bhote Koshi catchment is 297.66 km^2 with 46% of the total area classified as forest (Table 4.1 and Fig. 4.10). This is mainly concentrated on the upper slopes above 2,500 m asl. Cultivated land covers 25% of the catchment, the majority of which lies below 2,500 m asl. This can be divided into bari and khet terrace systems, dominated by bari. Bari land is formed of gently outward-sloping rain-fed terraces and khet land is a system of horizontal irrigated terraces almost always used for growing rice (Gerrard and Gardner 2000a). Khet terraces are generally located toward the valley bottom. Shrubland (15%) and pasture (11%) can be found at similar elevations up to 3,500 m asl. The area of barren land between 3,500 and 4,000 m asl is snow covered during the winter months.

Table 4.1 Land use within the Upper Bhote Koshi watershed. The values were extracted from the 1:50,000 digital topographic map (Department of Survey 2000).

Land use	*Area km^2*	*Percentage*
Forest cover	137.36	46
Cultivated land	75.74	25
Shrub land	44.82	15
Pasture	21.58	11
Barren land	8.16	3
Total	297.66	100

Although a full remote sensing based analysis of land use change was beyond the scope of this study, some observations based on a qualitative assessment of the imagery and a field survey can be made. Overall, between 1992 and 2007 little change in the land use pattern was observed including the spatial extent of forest cover. This is supported by discussions with villagers who reported various community forestry activities including the conversion of shrubland to forest and the zoning of the community forest to protect newly planted trees. Such projects were associated with both slope stabilisation and the sustainable management of the forest resource. These observations support the earlier findings of the Nepal Australia Forestry Project which investigated land use change in Sindhupalchok and neighbouring Kavrepalanchok District between 1978 and 1992 (Mahat *et al.* 1987a; 1987b) and the more general observations for Nepal where there has been an overall decline in rate of deforestation following a peak between 1985-1990 (FAO 2005). Joshi (1998) suggests that deforestation in the Hill districts of Nepal, whilst not insignificant, did not increase in rate in the 1990s. Instead, most of the deforestation during this time occurred on the Terai plains (see section 2.4.2).

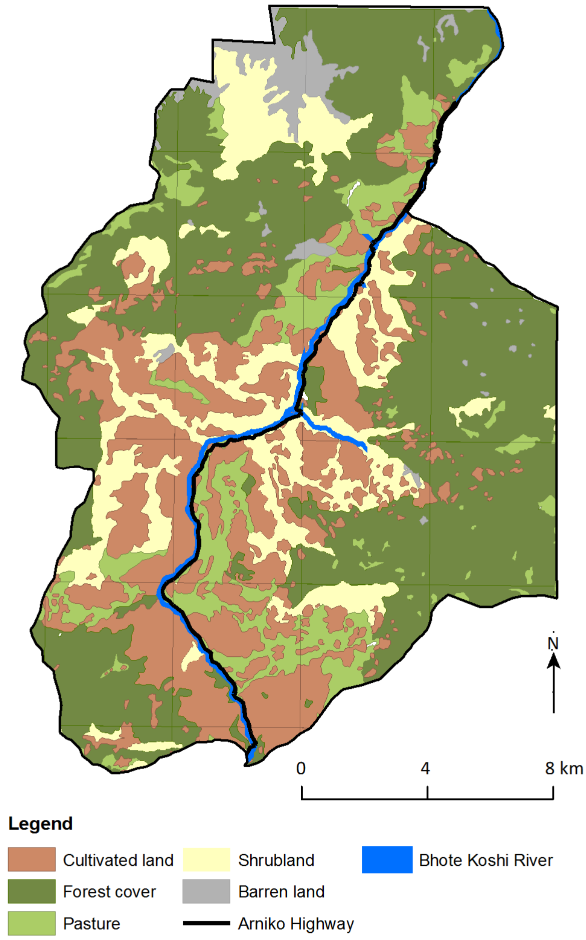


Figure 4.10 Land use map of the Upper Bhote Koshi Valley. Source: Department of Survey (2000).

4.4 Case study settlements

The study focuses on a 10 km stretch of the Arniko Highway where a number of landslide prone settlements have been identified, including the case study settlements of Chaku, Larcha and Kodari and three off-road settlements in the surrounding hinterland, Marmin, Duguna and Listi. In the absence of published hazard and/or risk maps for the Upper Bhote Koshi Valley, it was first necessary to identify the areas of unstable ground and areas of potential slope instability and the location of settlements in relation to these areas of landslide activity in the Upper Bhote Koshi Valley. This involved a desk study followed by field mapping exercise. The former involved the collation of relevant documentation including geological and topographic maps, consultants' reports and scientific papers to develop a preliminary ground model of the site (Charman and Griffiths 1993; Fookes 1997; Fookes *et al.* 2000; Charman 2001; Lee and Jones 2004). Aerial and terrestrial photographs taken as part of a hazard mapping project in 1989 (SDC 1989) and aerial photographs at 1:50,000 scale from 1992 were available along with high-resolution satellite imagery including a specially commissioned TopSat 5 m ground resolution multi-spectral image of the Upper Bhote Koshi Valley (QinetiQ 2007), that allowed the identification of landslides as small as 5 x 5 m, in addition to publically available Google Earth imagery of a comparable ground resolution.

Using the Google Earth images as a base map, detailed geomorphological maps were prepared for each case study settlement. The objective of the mapping exercise was to delimit and define past and contemporary landslide activity within the general area of each of the case study settlements (Lee and Jones 2004). A ground truthing exercise was undertaken over two ten day field visits in November 2006 and June 2007. This involved an extensive walk-over survey along the road corridor between Chaku and Kodari, and across the surrounding hinterland. Geomorphological maps were made in the field (for an example see Fig. 4.11) and a photographic survey undertaken. These maps were combined to produce detailed geomorphological maps of the field sites based on standard geomorphological mapping techniques (see, for example, Cooke and Doornkamp 1990; Brunsden *et al.* 2002).

Landslide nomenclature is often confusing, commonly transcending the many published landslide classification systems (for a summary, see Hansen 1984). In this study landslides were identified using the well cited and most widely recognised classification compiled by Varnes (1978) (see Chapter 2). The basis of the classification is the nature of the material involved (rock, debris, soil) and the movement type (fall, topple, rotational, translational, lateral, spread, flow). Additional observations were made including, where possible, the approximate footprint size of the failure, estimated by a combination of satellite imagery analysis based on the approximate width of the failure scar; and the land use type in which the failure occurred.

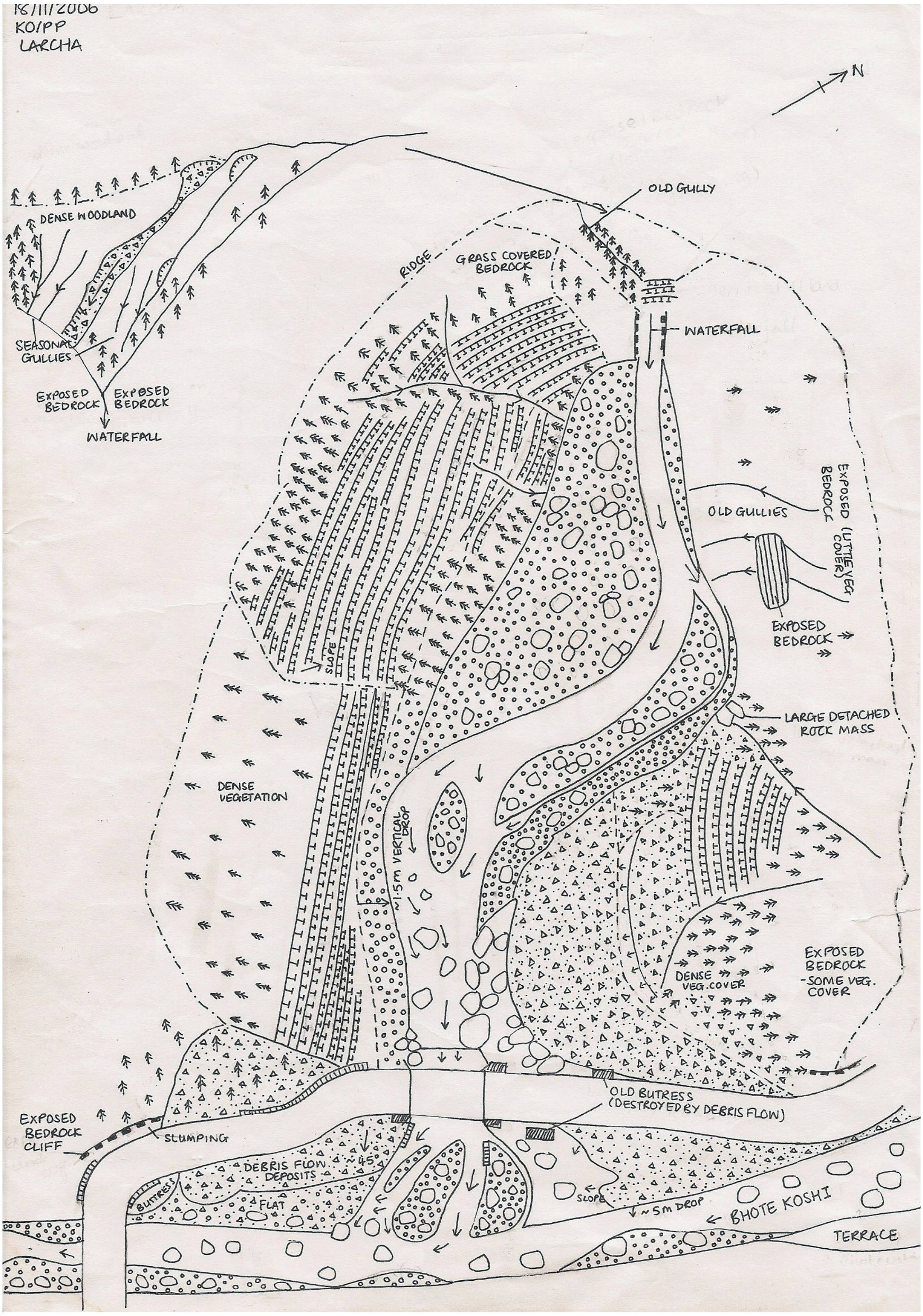


Figure 4.11 Geomorphological field map of Larcha. Source: Field mapping, November 2006.

4.4.1 On-road settlements

The roadside settlements of Chaku, Larcha and Kodari are located along a stretch of highway deemed to be particularly problematic due to landsliding, characterised by large, deep seated failures, with active gully erosion above and below the road, combined with high rates of river incision. While the level of landslide hazard can be seen to vary along the highway[1], in a number of areas the hazard is acute, with the occurrence of landslides characterised by high movement velocities and long run-out distances, often from a distal source area. These events sourced higher in the catchment, are commonly not anticipated, rarely directly witnessed, and hence have often catastrophic impacts down slope. The following section introduces each case study settlement along with other areas of interest along the highway with the aim of providing a context to the study area.

Chaku (Phulpingkutti and Marmin VDCs - 27°53’01.10”N; 85°54’50.45”E)
Total number of households: 93

Chaku can be divided into two settlements. The original settlement was built along the salt trade route, which passed through the Upper Bhote Koshi Valley linking Kathmandu and Tibet. The settlement, which comprised only five houses approximately 80 years ago, was constructed on the alluvial terrace between the Chaku Khola and the Bhote Koshi River. The settlement expanded significantly following the construction of the Arniko Highway in the 1960s with houses constructed at the roadside on colluvial and alluvial deposits and at the foot of steep northwest-facing quartzite and phyllite cliffs. An active translational slide in the lower slope adjacent to Chaku bridge destroyed five houses in 2001 (Figs. 4.12 and 4.13 A). The remaining four brick dwellings at the foot of the slope and a single dwelling on the landslide crown remain occupied despite evidence of continuing slope movement.

This is a complex slide comprised of soil, weathered and in situ rock material. The original failure scar is approximately 50 m wide but successive failures retrogressing up and across slope are putting a wider area and more houses and land at risk. In addition, a large colluvial fan is located at the southern end of the settlement with toe deposits approximately 100 m wide (Fig 4.12 and 4.13 B). Here, remobilised rock fall debris destroyed paddy fields and adjacent farmland in 2004 blocking the highway for approximately 10 days. Two relict smaller

[1] The vulnerability of roadside settlements to landslide hazard is driven largely by the geophysical setting. Dip slopes, for example, are more susceptible to rock falls than counter-dip slopes. Colluvial and alluvial deposits are more prone to failure than in-situ bedrock. Not all settlements along the road, therefore, experience the same level of landslide risk.

scale colluvial fans can also be seen (Fig. 4.13 C). These areas have been terraced and are presently used to cultivate maize and millet.

Figure 4.12 Left - The active translational slide in Chaku. Five houses were destroyed by a landslide in 2001 (A). A house remains occupied above the main scarp of the landslide (B) which is retrogressing up the hillslope putting more houses at risk. Right – A colluvial fan at the bottom of Chaku settlement. Evidence of secondary lateral slumping can be seen.

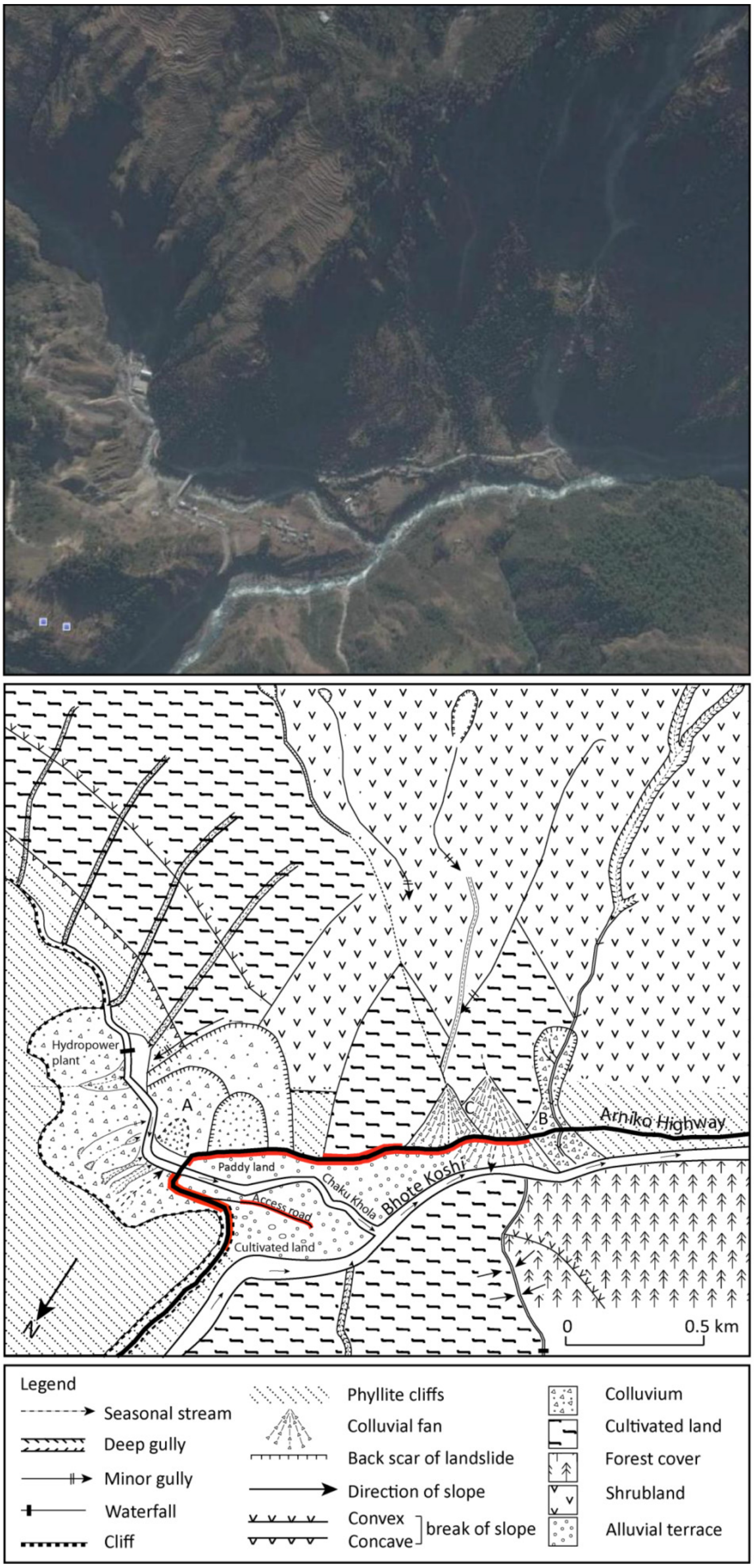


Figure 4.13 A satellite image (Google Earth 2009) and geomorphological map of Chaku showing the active translational slide (A), a large colluvial fan formed from remobilised rock fall debris (B) and the ancient colluvial fans (C). The red shaded area marks the settlement.

Approximately 2 km north of Chaku is the small roadside hamlet of “4 km Settlement”. Four houses have been constructed at the roadside on colluvial material at the bottom of a west-facing slope (Fig. 4.14). The slope beneath the houses is being incised by the Bhote Koshi River while the slope above is a source of frequent rock falls. Just before the settlement, approximately 1 km of highway was washed away in 2000 following extensive toe erosion by the Bhote Koshi River during flooding.

Figure 4.14 “4 km Settlement”. The house (A) was originally located where the goat shed is now (B) but was destroyed by a falling boulder in 2006. The strategic road linking Kathmandu and China (Tibet) is frequently blocked by landslides.

Larcha (Tatopani VDC - 27°55’57.68”N; 85°56’13.00”E)

Total number of households: 13

The settlement of Larcha is located at the confluence of the Bhairab Kunda Stream and the Bhote Koshi River, in the base of a steep sided gorge, characterised by steeply dipping phyllite rock walls. Larcha is at risk from landslide dam-break flood events and debris flow hazards from the catchment of the Bhairab Kunda Stream. Extensive networks of active gullies have been mapped characterised by high elevation source areas and complex tributaries that feed into the main stream channel (Fig. 4.15 and 4.16). On 22 July 1996, a channelised debris flow which formed after breaching a small landslide dam killed 54 people and destroyed 16 houses, 150 m of highway, a highway bridge and adjacent agricultural land. A combination of rainfall, runoff and stream undercutting triggered the failure of bedrock and colluvium on both the dip and counter-dip slopes approximately 750 m upstream from the settlement (Fig. 4.15 and 4.16 A). The landslide debris dammed the channel of the Bhairab Kunda Khola and was subsequently breached, inundating the village of Larcha. Adhikari and Koshimizu (2005) estimated that 104,000 m^3 of coarse clastic debris was deposited in the stream channel during this event.

Figure 4.15 Left - The Bhairab Kunda Khola. Extensive aggradation and erosion caused by the 1996 channelised debris flow resulted in the loss of farmland and the lateral migration of the stream channel. The Bhairab Kunda Khola (B) joining the Bhote Koshi River (C) below Larcha bridge (A). The inset shows the settlement of Larcha at the confluence of the Bhairab Kunda Stream and the Bhote Koshi River. Right – An active gully depositing material into the Bhairab Kunda Khola approximately 750 m upstream from Larcha.

Prior to this event the settlement was constructed along the road and on the alluvial deposits adjacent to the Bhairab Kunda Khola. Larcha has since been rebuilt, with nine houses constructed along the highway on the river side of the road, two at the foot of steep phyllite cliffs and two houses on the debris flow deposits laid down by the 1996 event, adjacent to the Bhairab Kunda Stream channel.

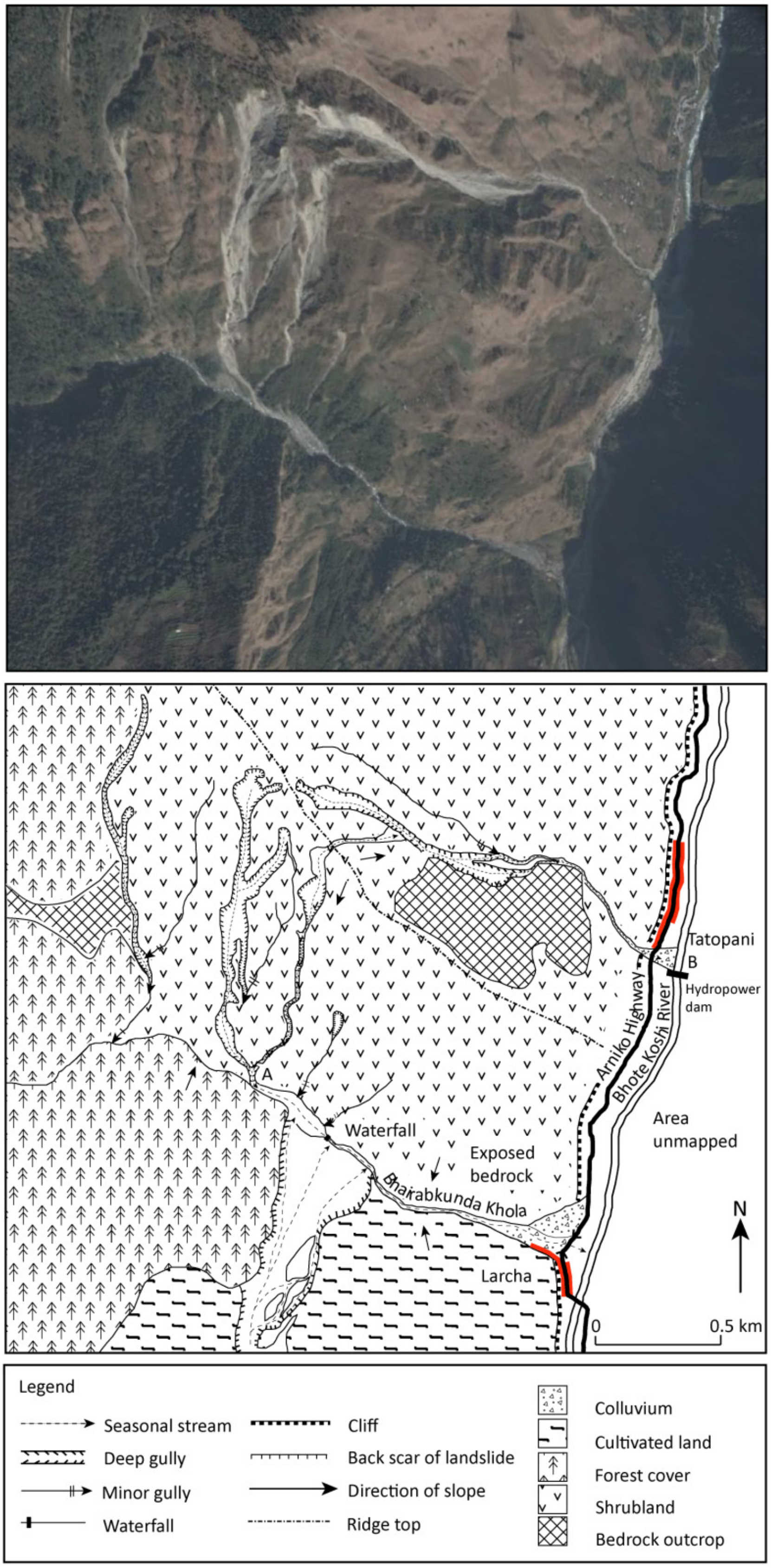


Figure 4.16 Satellite image (Google Earth 2009) and geomorphological map of Larcha showing the source of the landslide material which dammed the Bhairab Kunda Khola in 1996 (A) and the Tatopani debris flow (B). The red shaded area marks the settlement.

Approximately 1 km north of Larcha is the southeast-facing settlement of Tatopani, which is also at risk from debris flow events (Fig. 4.16 B). A debris flow in 2000 destroyed approximately 15 houses. Figure 4.16 maps the debris source and the active gully channel. Debris from the channel and surrounding hill slopes is frequently remobilised during rainfall events, partially blocking the Bhote Koshi River behind the Tatopani hydropower dam (Fig. 4.17). Despite this, houses in this settlement have been rebuilt on colluvial material adjacent to the debris fan.

Figure 4.17 The Tatopani debris flow reactivated following heavy monsoon rains in July 2007. Landslide material partially blocks the Bhote Koshi River behind the Tatopani hydropower dam.

Kodari (Tatopani VDC - 27°57’41.37”N; 85°57’23.60”E)

Total number of households: 25

The settlement of Kodari was destroyed approximately 60 years ago by a soil/rock slide and was subsequently rebuilt. The slope (approximately 250 m wide) failed catastrophically again in 1981 following a flood and incision by the Bhote Koshi River destroying 15 houses, a post office and farmland (Fig. 4.18 A). The houses and farmland were subsequently abandoned with the displaced population resettled by the government onto adjacent public land. Construction on the slope began approximately five years ago, with the household displaced by the landslide constructing houses to let. There are now sixteen houses constructed on the

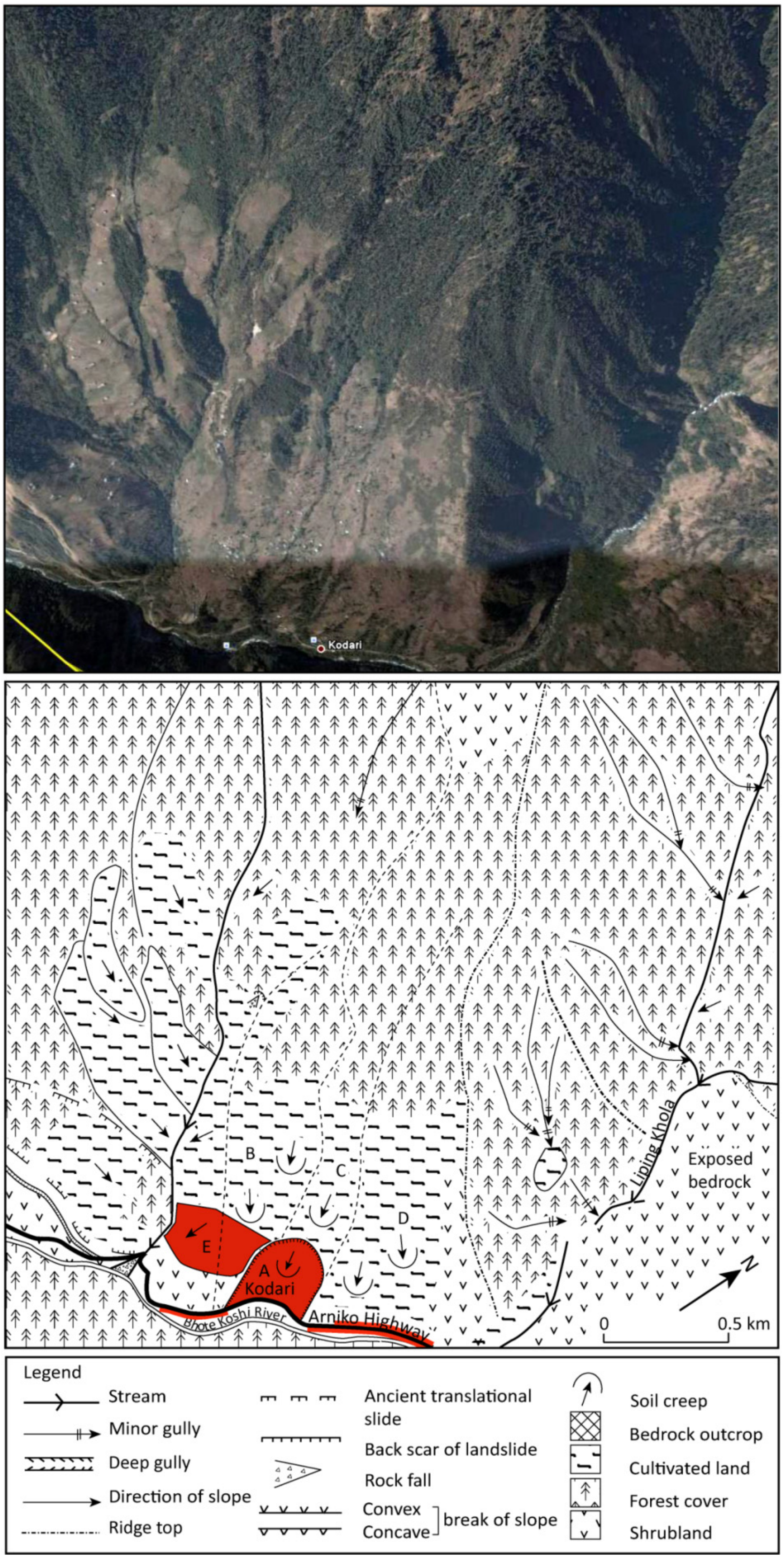


Figure 4.18 Satellite image (Google Earth 2009) and geomorphological map of Kodari. A indicates the failed slope; B, C and D incipient landslides associated with soil creep. The red shaded area marks the settlement.

landslide, with many accommodating more than one family (Fig. 4.19). Continuous incision by the Bhote Koshi maintains the active deformation of the slope. Evidence includes visible cracks in the walls of a newly constructed hotel on the site, twisted gabion walls at the roadside and marked changes and crack in the level of the road surface (Fig. 4.18). Three additional slides have been noted close by (Fig 4.18 B, C and D) suggesting that the entire hillside is deforming due to landsliding.

Figure 4.19 The roadside settlement of Kodari. Inclining trees, marked changes in the level of the road and cracks in the Eco Hotel (bottom photograph) are indicators of continuous slope movement.

4.4.2 Off-road settlements

The landslide hazard in the high hills can be described as chronic. Landslides frequently occur but these are characteristically large, slow moving failures that damage property and farmland, usually without human loss. Some failures that originate in these higher elevation areas run-out down slope and reach the valley bottom, but this is only apparent for a small number of the highest magnitude events. Small landslides, usually involving the collapse of agricultural terraces, are common phenomena particularly during the monsoon months.

Marmin (Marmin VDC - 27°52’22.19”N; 85°55’03.07”E)

Total number of households: 67

The settlement of Marmin is located above the valley bottom settlement of Chaku on a north-east facing slope. The settlement was originally located on an adjacent site, now termed ‘Old Marmin’, but was destroyed by a landslide approximately 60 years ago (Fig. 4.21 A). This slow moving failure was active over a period of approximately one month, destroying an estimated 60 houses and associated farmland resulting in the relocation of Marmin to its present site. Local accounts and geomorphological evidence suggest this was a rotational failure in colluvium material. The present day location of the settlement also shows evidence of continuous slope movements, including inclining trees. The active translational slide at the toe of the slope in Chaku, below, has caused the collapse of terraces and the loss of farmland in Marmin (Figs. 4.20 and 4.21 B). Heavy and persistent rain during the 2006 monsoon triggered a landslide on an adjacent slope near Old Marmin (Figs. 4.22 to 4.23). The rotational landslide and rock fall with a failure scar of approximately 250 m high, destroyed two houses and associated farmland in Chambang and remains active today.

Figure 4.20 Terraces destroyed by the active translational slide at the bottom of Marmin settlement.

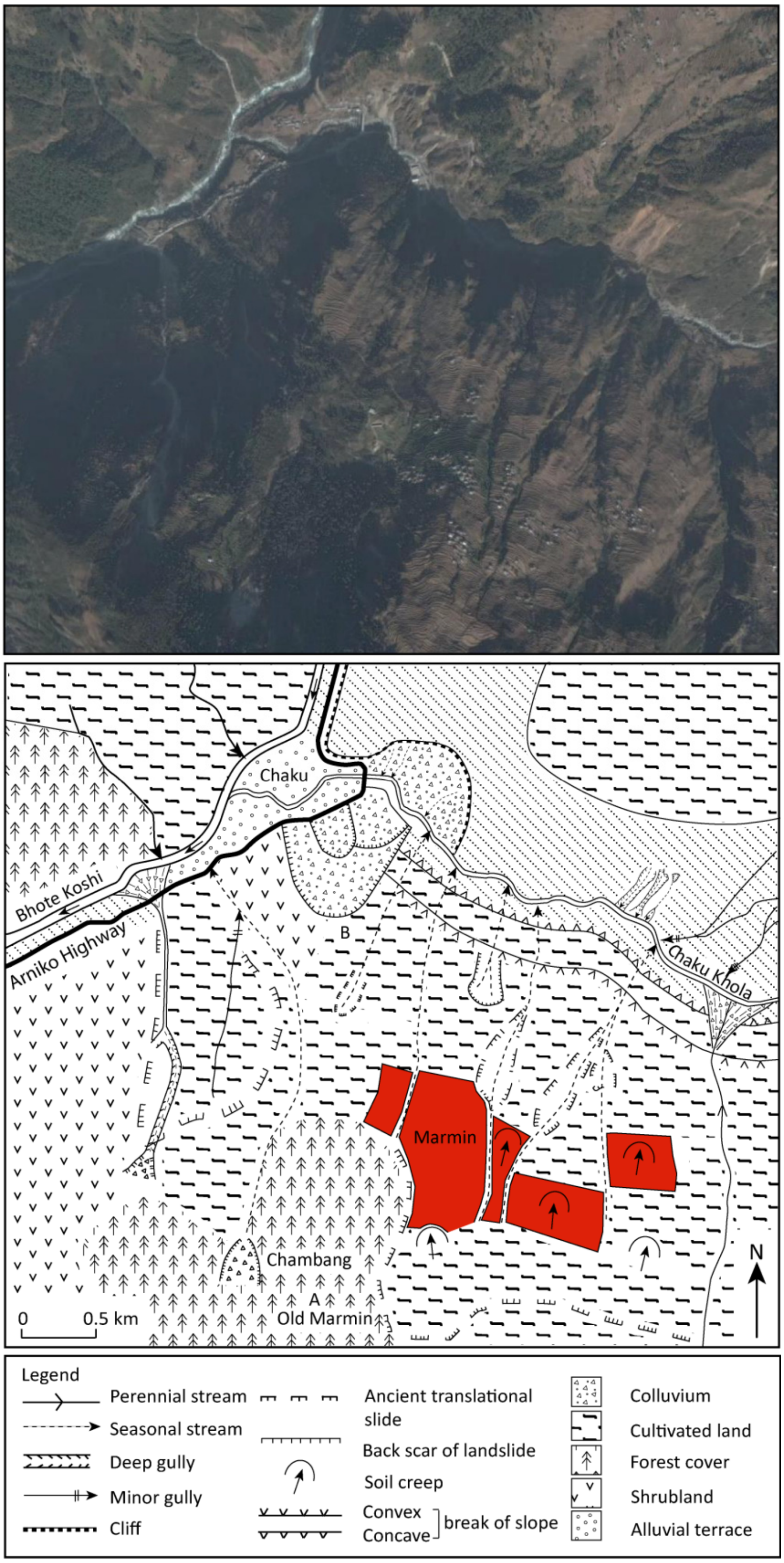


Figure 4.21 A satellite image (Google Earth 2009) and geomorphological map of Marmin showing the ancient rotational slide (A) and collapsed terraces above the active translational slide at the bottom of Marmin settlement (B). The red shaded area marks the settlement.

Figure 4.22 The 2006 Chambang landslide (left) and an active gully (right). This rotational slide and rock fall were triggered by heavy and prolonged monsoon rainfall.

Figure 4.23 The 2006 Chambang landslide.

Listi (Listikot VDC - 27°53’42.61”N; 85°52’19.03”E)

Total number of households: 64

Listi is located on a gentle north-east facing slope approximately 1,000 m above the Bhote Koshi River. The settlement itself has been unaffected by landslides although a number of boulders (possible rock fall deposits) were noted below the ridge top nearby. Bari terraces cut into the steep slopes below the settlement in Paikosa and neighbouring Pangsing have been subject to slope failure (Fig. 4.24). A soil and rock slide (rotational in form) destroyed farmland in Paikosa approximately 10 years ago (Fig. 4.25 A). The landslide is now inactive and, where possible, terraces have been rebuilt. A rock/soil fall with a failure scar approximately 5 m high occurred in Pangsing in 2004 and has been linked to the construction of a minimally engineered rural road between Listi and the Arniko Highway (Fig. 4.24 and 4.25 B). The failure occurred in steep terrain (approximately 26-35 degrees) and remains active today. A number of small active failures comprising of rock fragments and loose granular soil were also observed along the alignment of this roadway (Fig. 4.24b).

A

B

Figure 4.24 (A) The 1997 Paikosa landslide. The newly cut terraces in the foreground are an indicator of past landslide activity. Small boulders can be seen on the older terraces.

(B) The 2004 Pangsing landslide (foreground). Inset photograph shows the rural road.

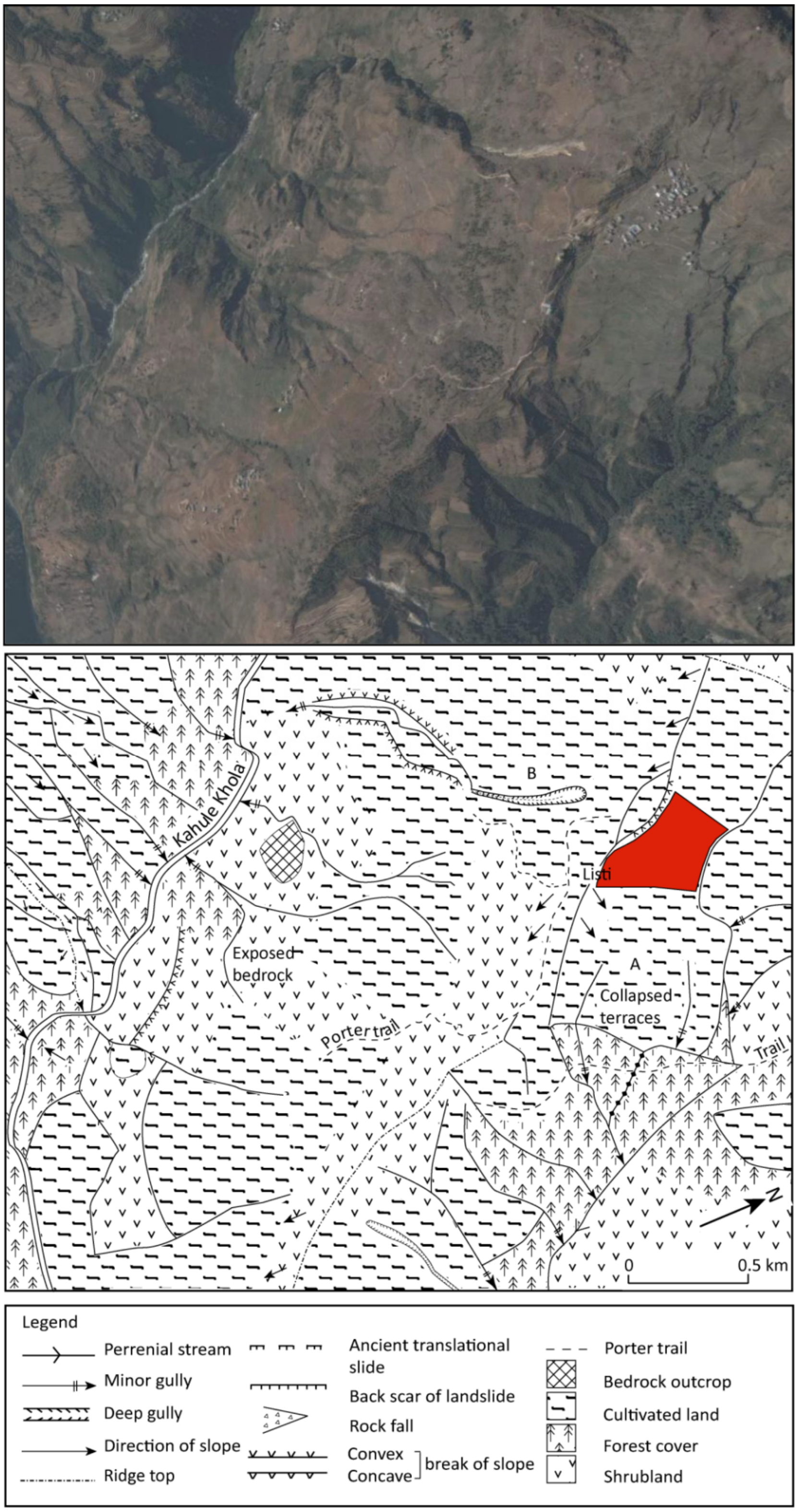


Figure 4.25 Satellite image (Google Earth 2009) and geomorphological map of Listi. (A) The Paikosa landslide and (B) the 2004 Pangsing landslide. The red shaded area marks the settlement.

Duguna (Tatopani VDC - 27°55’11.97”N; 85°54’52.51”E)

Total number of households = 71

Duguna can be divided into three north-east-facing sub-settlements: Yarmasing, Bhoomachour and Patikuna. Yarmasing and Bhoomachour are located on an active earth flow; a slow moving failure occurring in the relatively fine grained material (Fig 4.26 and 4.27 A). The earth flow is approximately 500 m wide and shows evidence of active surface deformation. The ground in Duguna is heavily saturated with the streams and gullies coalescing into larger channels and torrents during the monsoon months. This high influx of water into the unstable slope is a likely cause of the continued observed deformation at this site. There is also evidence of three relict translational slides (Fig. 4.27 C, D and E), with the main failure occurring approximately 120 - 130 years ago. Patikuna is susceptible to rock falls, with a large event occurring approximately 45-50 years ago (Fig. 4.26 and 4.27 B) destroying six houses and leading to the relocation of householders to neighbouring Bhoomachour. Following a period of quiescence the area has been resettled.

Figure 4.26 The settlement of Yarmasing located on an active earth flow (A). The inset photograph shows rock fall deposits in Patikuna.

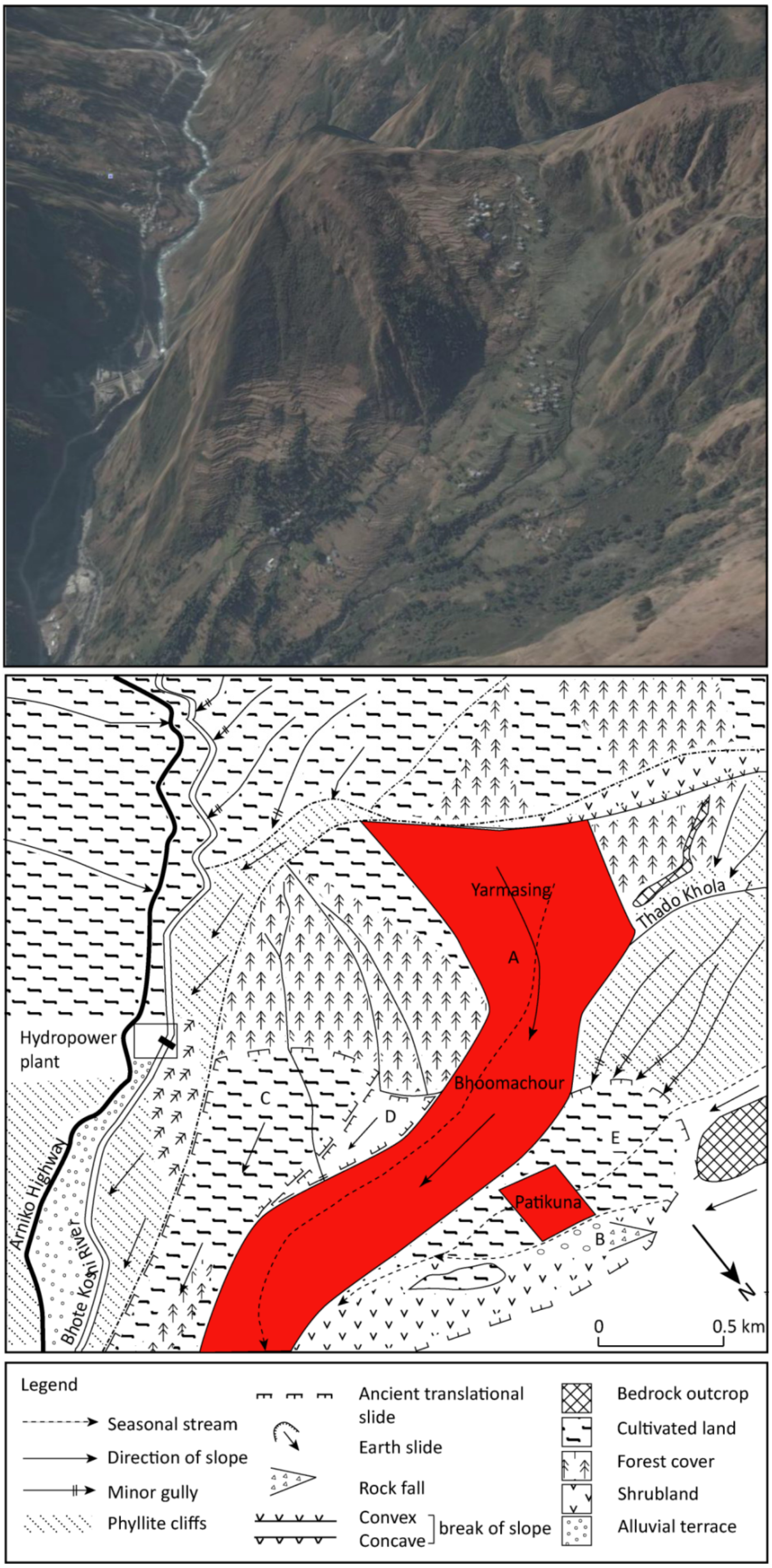


Figure 4.27 Satellite image (Google Earth 2009) and geomorphological map of Duguna showing the active earth flow (A), the Patikuna rock fall (B) and three relict translational slides (C, D and E).

4.5 Summary

This chapter has provided an introduction to the study area and the six case study settlements in the Upper Bhote Koshi Valley (Table 4.2). As the field mapping and satellite imagery analysis has shown, the nature of the landslide hazard varies on and off-road in terms of failure magnitude, type and likely future behaviour. The off-road settlements of Marmin, Duguna and Listi are susceptible to large, slow moving failures that destroy property, infrastructure and agricultural assets, usually without human loss. By comparison, the roadside settlements of Chaku, Larcha and Kodari have been constructed at the bottom of steep, unstable slopes and on colluvial and alluvial deposits commonly adjacent to incoming stream channels. Here, the landslide hazard is acute and potentially catastrophic, given the susceptibility of these channels to damming and breaching by relatively small scale upslope landslides as demonstrated by the 1996 Larcha debris flow. Of course, the dichotomy presented here between the on and off-road locations is not always as stark. As discussed in Section 4.4.1, not all roadside settlements in the Upper Bhote Koshi Valley experience the same level of landslide hazard. There are, however, fundamental differences in the landslide characteristics on and off-road which can be seen to influence the vulnerability of the exposed population. As discussed in Section 1, any attempt to understand landslide risk also requires an understanding of the social factors that give rise to the vulnerability of local people. The following chapter introduces the methodologies drawn from the social sciences used to investigate this vulnerability.

Table 4.2 Landslide hazard in the six case study settlements

Location	*Settlement*	*Date*	*Landslide hazard*	*Trigger*	*Impact*	*Current activity*	*Exposure assessment*
On-road	Chaku	June 2001	Translational slide	Monsoon rainfall	5 houses destroyed	Active	5 houses Successive failures are retrogressing up the slope putting more houses at risk
		2005	Rock fall	Monsoon rainfall	Farmland destroyed Highway blocked for 10 days	Active	Highway and farmland
	Larcha	July 1996	Channelised debris flow	Monsoon rainfall	54 people killed 16 houses destroyed Farmland destroyed	Active	13 houses Highway and farmland
	Kodari	~1945 1981	Soil/rock slide Soil/rock slide	Unknown GLOF	5 houses destroyed 15 houses destroyed Farmland destroyed	Active	16 houses Highway Eco Hotel and Resort
Off-road	Marmin	~1945	Rotational slide	Unknown	60 houses destroyed – settlement relocated	Active	Land abandoned
		June 2001	Translational slide	Monsoon rainfall	Farmland destroyed	Active	Farmland
		July 2006	Rotational slide and rock fall	Monsoon rainfall	2 houses and farmland destroyed	Active	Land abandoned
	Duguna	July ~1960 Continuous movement	Rock fall Earth flow	Monsoon rainfall -	6 houses destroyed – temporary relocation No impact observed to date	Inactive Active	- ~65 houses Farmland
	Listi	June 1996/7 2004	Soil and rock slide Rock/soil fall	Monsoon rainfall Monsoon rainfall	Farmland destroyed Farmland damaged	Inactive Active	- Farmland

Source: Community profiles and household interviews, October 2006 and May 2007

Chapter 5

Researching Landslide Vulnerability

'[R]*esearch in the Third World very often feels rather chaotic. It is not simply that the logistics are likely to be complex, the bureaucratic hurdles wearying and often alarming, and the risks (of ill-health for example) very obvious…Is it also not only because the researcher, particularly if alone, is very dependent on and very exposed to local people, although that is both a privilege and often a very considerable personal challenge. No, the unnerving thing…is the way in which the fieldwork can warp and re-mould the research itself.'*

(Adams and Megaw 1997: 215)

5.1 Introduction

The above quotation neatly summarises my own experiences of undertaking fieldwork in Nepal. All too often accounts of research methods *'tend to hide the complexities…and the uncertainties that dog actual research experiences, replacing them with smooth, powerful and logically constructed methodologies that sound convincing and 'professional'. Too often, our accounts of what we have done draw on selective memory and a desire to conform and convince a critical First World audience'* (Adams and Megaw 1997: 216) . My *'neat ideas'* (ibid) formulated in a university in the Global North were challenged from the moment I arrived in Nepal where I found myself continually being caught out by the reality of fieldwork. I aim, here, to present an honest and reflexive account of my fieldwork experience examining vulnerability to landslides.

My fieldwork was undertaken over five months with a total of four visits to Nepal. The first, a two week reconnaissance visit, was undertaken in March 2006. This was followed by two, two month field visits in October 2006 and April 2007. My April visit coincided with the start of the monsoon and during my time in the field I saw the reactivation of the Tatopani debris flow (See section 4.5.1) and a rock fall along the Arniko Highway. However, the 2006 and 2007 monsoons were relatively weak. I did not, therefore, see the Middle Hills of Nepal at their most active and this has undoubtedly influenced my own perceptions on landslide hazard and risk in the Upper Bhote Koshi Valley. A final three week visit was made in June 2008 to disseminate my research findings and to undertake a series of interviews with technical specialists (including geologists and engineers) and policy advisors. This chapter sets out how the research was organised and conducted and how the findings were analysed. I also examine my own positionality and the representation of data gathered. Finally, I discuss the problems that were encountered, how these were confronted and the compromises that had to be made in the process.

5.2 The epistemology of researching landslide vulnerability in Nepal

When I began my field work in 2006, I entered the field with a particular vision of 'the problem' based on my reading, the evidence available to me and my own preconceptions. My interest for this work stemmed from my Masters research, in which I used a global scale database to analyse the impact of landslides, particularly focussing on Nepal (Petley *et al*., 2007). The findings highlighted the concentration of landslide-induced fatalities in the Himalayan Arc and, specifically, the high number of fatalities year on year in Nepal. Nepal was therefore subject to a chronic landslide problem in both relative and absolute terms. However, contrary to these ideas, when my fieldwork commenced it rapidly became clear that landslides were not a priority concern for rural householders in Nepal. This made me question my research and, while landslides remained the focus of my study, I became far more critical and reflexive. I also became interested in the discourses around landslide risk management from different stakeholder perspectives and how these compared to the lived experience in rural Nepal. My research has therefore crossed a number of different epistemological positions. Starting, as I did, from a natural science perspective, my epistemological approach was largely positivist. I applied the methods of natural science to gather empirical evidence with the aim of generating an objective, value free 'truth' (Robson 2002). Over the course of the research this position gradually shifted, often in response to the evidence as it emerged so that now I take a more realist and sometimes weak constructionist approach to my research whereby landslides are viewed as an objective hazard which is mediated through social and cultural processes (Wisner *et al.* 2004). I do not discount the relevance of empirics when it comes to understanding landslides, but have come to realise that 'facts' are slippery and that explanatory frameworks need to be contextually attuned.

5.2.1 Positionality

As noted by Skelton (2001), it is crucial in any research that we consider our positionality and what that might mean in relation to the ways in which we do our research, and how the people we work with perceive us. Skelton (ibid) defines positionality as *'things like our "race" and gender…but also our class experiences, our levels of education, our sexuality, our age, our ableness, whether we are a parent or not. All of these have a bearing on who we are, how our identities are formed and how we do our research. We are not neutral, scientific observers, untouched by emotional and political contexts of places where we do our research.'* (p.89).

Throughout my time in the Upper Bhote Koshi Valley I was uncomfortably aware of the power relations between myself and my informants: I was a white British citizen, educated and an outsider. I recall a conversation I had with my host in Listi who asked me how many years I had been studying. With few children in the village proceeding beyond primary school (just four years of schooling) I felt embarrassed but wanted to be honest. I was 25 years old and had spent 20 years of my life in education. My host responded with *"that is a lot of education"*. The people I interviewed were surprised that I had come to Nepal on my own and wanted to know why I was not at home with my family. The young women were particularly surprised that I was unmarried at the age of 25 and that I didn't have any children.

My outsider status often placed me in an uncomfortably privileged position. It has been argued in the literature (see, for example, Lavers 2007) that respondents are likely to give responses that they think the researcher wants to hear; or responses that anticipate what the researcher might be able to deliver. I did not find this to be the case (this is discussed in more detail in Chapter 7), however, as with all research, the answers given by respondents depend, to some extent, on the rapport developed between researcher and respondent. Building a relationship of trust over what was, by anthropological standards, a relatively short period of fieldwork was my greatest challenge. I often felt marginal in the community. Like Swanson (2008), who undertook research with indigenous women and children in Ecuador, I did not have a respected role in the community, I asked too many obvious questions, was unable to follow the conversations in Nepali, Sherpa or Tamang and I spent a lot of my time writing in my notebook. I was a novelty rather than an accepted member of the community. As a Chhetri woman in Larcha said to me in response to my questions about what it was like to live in the village, *"come and live with me for a few years and you'll find out".* Although her answers to my questions would reveal a certain amount of information, only the experience of living in the village would show what daily life was really like. Her comment has stayed with me throughout my research and I return to this in section 5.3.3.

Sometimes my 'outsider' position helped. I was often treated as an honorary man and as such the male members of the village were willing to talk to me, while local elites (VDC officials and the leaders of community groups) saw it as their duty to assist me with my research. Being a woman I was also able to engage with the female members of the community. A few women, however, were reluctant to share their opinions and views. I suspect this reflected a concern that they did not know the 'correct' answer and they would simply tell me to speak to their husbands (I return to this again in Chapter 7). The women saw my vulnerable side, I was not a threat but a young woman in Nepal on my own and they often mothered me. They would laugh at my attempts to wash my clothes at the village water tap and would often snatch them from me to show me how it should be done. It was activities like this that gave me a way into the community. Unsurprisingly, perhaps, I spent much less time considering my positionality when interviewing the technical specialists and policy makers. This is because I had aligned myself more closely with this group. However, issues of positionality did arise and these are discussed in section 5.5.1.

5.3 Research practicalities and logistical arrangements

5.3.1 Research permission

Advice regarding permissions for undertaking research was sought from colleagues at the Nepal Landslide Society and the Mountain Risk Engineering Unit in Kathmandu, and an official letter of support was drafted in Nepali. A visit to the district Headquarters in Chautara was required in order to gain permission from the district authorities to conduct the research. Meetings were arranged with the Chief District Officer and the Local Development Officer. Aware that the Maoists were in *de facto* control of Sindhupalchok District meant that approval from the Nepali government to conduct the research did not imply that it would be possible to do so. I was fortunate that there was a tourist resort not far from my field sites and they were able advise me on this. They put me in touch with the local 'gatekeeper' who seemed happy for me to undertake the research and offered his assistance. At community level, permission was sought from the village elders. I was hoping to arrange village meetings to introduce myself and my research assistants, and to describe the aims and objectives of the research in detail, but this was not always possible given villagers' busy lives. I opted instead to introduce the research each time I undertook a household survey.

5.3.2 Gaining consent

For the technical specialists and policy makers interviewed, an information sheet and consent form outlining the aims and objectives of the project, a description of the researcher, the duration and nature of the research and the role of participants was prepared (Appendix 2). However, at village level, where the majority of research participants were non-literate, such an approach was felt to be inappropriate. I personally felt very uncomfortable asking people to sign or thumbprint a form that they could not read and which was meaningless to the research participants. I was also aware that in light of the ongoing political conflict, participants were nervous about 'official' surveys through fear that household data would be used against them either by government or Maoist forces. In Marmin, for example, participants were happy to assist with a study on landslides but were reluctant to give out household information and despite a detailed explanation from me regarding the nature of the research they remained suspicious of my motives. With this in mind, I followed the recommendations of Scheyvens *et al.* (2003) who suggest that in such contexts it may be more advisable for the researcher to sit down with potential participants and introduce oneself and the research in detail and to gain consent verbally. In terms of writing up the research, standard confidentiality practices adopted in social science research have been employed, with respondents identified by their age, gender and ethnicity and, in the case of the technical specialists and policy makers, their profession and affiliation only (Valentine 1997). Any names used in this thesis are pseudonyms.

5.3.3 Language and translation

One of the biggest challenges in undertaking the research was language. Unable to speak Nepali or the local ethnic languages of Tamang or Sherpa, I was heavily dependent on my research assistants. Following the guidance of Devereux (1992) it was useful to learn some of the important vocabulary to enable me to follow the interview. Effort was also made to communicate in Nepali where possible for example, introducing myself and my research to participants (Smith 2005). However, despite my best efforts, I struggled with the nuance of the pronunciation. This seemed to be the source of much amusement amongst villagers, who seemed to appreciate my efforts, helping to develop rapport in the interviews.

Interviews were conducted in Nepali with the exception of two; one of which was conducted by my research assistant in Hindi and the second in Tamang. In this instance a villager fluent in both Tamang and Nepali translated between my research assistant and the village elder. Using translators is not an ideal situation. I was present at the majority of interviews enabling me to direct the interview and ask follow-up questions as and when required. The questions were asked in Nepali by my research assistant and the responses translated back to me allowing me to make detailed notes in English. I was aware of the problems associated with this method. For example, the interpreter may take it upon him or herself to omit or change elements of the interview because they believe the information is irrelevant or of little use to the research topic (Devereux and Hoddinott 1992). Or, as in Le Mare's case (2007), her field assistants sometimes saw their role as helping the informants to give the "correct answer". They questioned why she wanted to understand the informants' responses if they were "wrong". Conscious of this permanent 'filter' I found myself constantly verifying the translated response with my research assistant and emphasising the need for a verbatim translation. Recording and transcribing the interviews was not a practical option given the language barrier.

I was also aware of the potential difficulties in mapping ideas between and across cultures and from one language to another (Twyman *et al.* 1999). Elsewhere it has been argued that we must submerse ourselves in culture and language before we can begin to understand people's view points and perspectives; the implication being that fieldwork and its interpretation is better when undertaken by a native speaker (see, for example, Radcliffe and Laurie 2006). Whilst I acknowledge this viewpoint, and recognise the challenges associated with undertaking cross-cultural research, I do not believe it is impossible. Although in an ideal situation, it would seem appropriate for a study with this sensitivity to follow on and build upon the research which I have undertaken. It is essential to be realistic in terms of the aims and objectives of the research, for example, as a non-native speaker I could not undertake an in-depth ethnographic study, which was never my intention from the outset. Working through interpreters meant there was a compromise in terms of the methods used. Focus groups, for example, are a particular challenge in another language. With this in mind, I felt surveys, semi-structured interviews and participatory methods were the most effective, enabling me to engage with my respondents, facilitate the discussion and to explore the subject in detail.

5.3.4 Research assistants

For each field visit, two research assistants were recruited to act as translators and to assist with the data collection (Table 5.1). They also provided a much needed way into the research community, gaining access to research participants and facilitating my acceptance (Ellen 1984). I recruited recent university anthropology graduates who had a good understanding of development, experience of ethnographic methods and conducting research in Nepal, and who were fluent in Nepali and English.

Given the study area was occupied by caste Hindu and Hill-tribe households, I was aware of the need to consider caste relations. Despite attempts to overcome the legacy of caste, ethnic and gender-based exclusion following the establishment of democracy in Nepal in the early 1990s, these ideas have remained deeply entrenched (for an in-depth discussion see Murshed and Gates 2005 and Bennett 2005). The high caste Brahmins, Chhetris and Newars dominated while the low castes and indigenous ethnic groups were marginalised (Schneiderman and Turin 2004). Recruiting research assistants of hill ethnic origin was therefore difficult, with the majority of English speaking graduates in Kathmandu being high caste Hindus; while the language barrier prevented the recruitment of research assistants from the study area itself. Working within these constraints, I sought advice from colleagues in Nepal and recruited research assistants with extensive field experience engaging with different caste and ethnic groups across Nepal.

I was also conscious of potential gender issues (see, for example, Heyer 1992; Razavi 1992) and as a result a male and female research assistant were employed. It was felt that a female research assistant might better engage with women participants and that a male research assistant would counter-balance the fact that I was a woman conducting fieldwork alone in Nepal. However, this did not work out as well as I was hoping. My female research assistant was very quiet in interview situations and the interviews she conducted lacked the depth I was seeking. My male research assistant on the other hand, developed a good rapport with both male and female respondents. This, perhaps, highlights the point that no matter how careful one is in choosing research assistants who fit an idealised template in terms of age, gender, ethnic origin, language skills and so forth, sometimes the critical issue is whether they are individually good interviewers and this can surpass all other factors and considerations.

Table 5.1 Research assistants used for fieldwork

Name	*Sex*	*Age*	*Marital status*	*Religion*	*Education*	*Employment*
Yubaraj[1]	M	25	Single	Hindu	MA Anthropology	Student
Bhawana[1]	F	25	Single	Hindu	MA Anthropology	Student
Kiran[2]	M	26	Single	Hindu	MA Anthropology	Teacher
Pragya[2]	F	27	Single	Hindu	MSc Genetics	Rural Access Programme PR Officer

[1] Fieldwork period: October and November 2007
[2] Fieldwork period: May and June 2007

5.4 Researching landslide vulnerability in rural Nepal

My first period of data collection (October and November 2006) focused on the three on-road settlements of Chaku, Larcha and Kodari. These settlements were selected based on their exposure to landslide hazard (see Chapter 4). Based on my findings, my second period of fieldwork (May and June 2007) focused on three off-road settlements: Marmin, Duguna and Listi, where people have migrated from to live by the road. This enabled me to explore the factors and forces shaping the human occupation of landslide prone areas and the associated decisions made.

The household formed the basic unit of survey and analysis. Whilst I acknowledge that households are a problematic category, both in terms of how the household unit is defined (do you include family members who reside outside the village, for example), and how decisions are made, it is nonetheless also true that in most societies – including rural Nepal – individuals are situated within families and households. It is the family or household that operates as the unit out of which decisions 'emerge'. As noted by Rigg (2007) *'it is extraordinarily difficult to extract the individual from the family or household of which they are a component part. Not only is it difficult; such an effort would be misguided. Individual desires, motivations and decisions are tempered, guided and sometimes dictated by the individual's locus within a household*' (p.44). This is not to say that we can treat the household as an *'individual by another name'* (Folbre 1986: 20). Households contain individuals with different needs, views and desires and the decisions that emerge are characteristically not arrived at in spirit of democratic negotiation, but reflect asymmetries of power often linked to age and gender. The village and community are also important units of analysis and likewise need to be problematised, particularly when 'communities' are little more than settlements consisting of households with very different origins. Exploring the links, associations, relationships and commitments that exist beyond the family and the household into wider social and spatial arenas (cf. Rigg 2007) was central to understanding the vulnerability context.

Data collection was based on an iterative, rolling programme of surveys, interviews and participatory methods. The surveys were undertaken to gain basic socio-economic data about each household in a standard format that would allow comparisons to be made between households and settlements. Follow-up questions were asked and notes were taken throughout providing clearer insights into the results of the pre-planned survey. The semi-structured interviews were designed to explore the topics of risk perception and response. I chose this method because I was interested in the situated knowledges of the people I interviewed. Semi-structured interviews enabled me to set some parameters for the discussion, enabling comparisons to be made between responses, but also gave some degree of flexibility. For a more in-depth understanding of the impact of landslides on rural livelihoods, I conducted a series of oral histories with villagers directly affected by landslides. The participatory methods, including walk-over surveys and mapping exercises, enabled me to explore local knowledge of the geographical and social environments. A mixed-methods approach such as this enabled me to triangulate findings between the different research methods (Ellis 2000). Each methodology is described in detail below.

I began my field research in each village with a series of informal meetings with village elders and other key informants including local level officials[1] in order to gain an understanding of the village context. Here, I was flexible in my approach, as what worked for one village did not necessarily work for another. For example, I found it impossible to draw the residents together for a village meeting in the on-road settlements, but off-road it was relatively straight-forward and the villagers seemed keen to attend. I used these initial informal meetings to begin to compile a profile of the community.

5.4.1 Community profiles

The community profile incorporates data from a range of participatory techniques including key informant interviews; walk-over surveys; and participatory mapping exercises. The aim of the profile was to provide *'a detailed, systematic ethnographic description of the community context within which the people and processes to be studied are immediately located'* (WeD 2006) (Table 5.2). The community profile (Appendix 3) was a working document and as such was updated and modified with additional data as the fieldwork proceeded.

Evolving from the 'participatory rural appraisal techniques' used in community development work in the South (Chambers 1997), participatory methods enable those conventionally 'researched' to become directly involved in the research itself (Pain 2004). Such approaches are *'designed to be context-specific, forefronting local conditions and local knowledge, and producing situated, rich and layered accounts'* (ibid: 653). Through a wide range of techniques, local people are encouraged to generate their own data and voice their priorities while outside researchers take on the role of facilitator learning about local conditions and the reality on the ground (Williams and Dunn 2003; Wisner 2006). The participatory methodologies employed in my research are outlined below.

Key informant interviews

Key informants were identified in each of the case study settlements. They included village elders, active members of local institutions such as the Village Club, Women's or Mothers' groups and local government officials. Informal interviews were undertaken with key informants at the start of the research providing an informed introduction to the village community.

[1] Due to the Maoist Insurgency (1996-2006), the VDC Secretary was the only local level government official available at village level.

Table 5.2 Community profiles: methods employed and data generated.

	Information/data required	*Methods employed*
Physical description of the settlement	Physical environment Natural resources/land use Infrastructure/facilities	Walk-over survey Key informant interviews Participatory mapping
Population and demographic characteristics	Number of households Caste/ethnic groups Language Religion Type of household Poverty level Household location	Baseline survey Household poverty assessment Sketch maps with GPS readings
Historical background	Age of settlement First settlers Settlement change over time Migration patterns	Key informant interviews Timeline Walk-over survey Participatory mapping
Material resources	Employment Savings and credit Market Infrastructure Government and non-government services	Baseline survey Walk-over survey
Human resources	Schools Health care facilities Community groups	Key informant interviews
Socio-political resources	Social and political groups Local institutions	Key informant interviews
Cultural resources	Traditions and beliefs Religious and non religious events	Key informant interviews Household interviews

Adapted from: WeD (2006)

Walk-over surveys

A walk-over survey was undertaken with key informants through each case study village and the surrounding land. Questions were asked regarding the history of the settlement, land-use and the occurrence of landslides. Photographs and notes were taken throughout.

Historical profiles

Historical profiles were compiled through informal conversations and interviews for each of the case study settlements, with the aim of providing an overview of the recent history of each settlement. Participants were asked to identify significant political, socio-economic and natural events such as earthquakes, landslides, construction of a new school building, the provision of electricity, or the construction of a road.

Vulnerability and capacity analysis

I based this exercise on Anderson and Woodrow's (1989) 'Capacities and Vulnerabilities Analysis Matrix', a simple six box matrix to aid risk assessment (Appendix 3). Community members were asked to consider their community capacities and vulnerabilities. This provided an interesting insight into local perceptions of risk (including people's concerns and priorities at the individual, household and community level) and coping mechanisms, for example kinship ties, religious observance, and community groups, at the village level.

Participatory mapping exercise

The participatory mapping exercise sought to elicit local knowledge on each case study settlement, including the identification of landslide prone areas. The exercise was conducted in small groups of three to four people to encourage participation and to avoid larger and more intimidating gatherings where knowledge and information might be concealed (Brockington and Sullivan 2003). Whilst aware of the potential gender issues whereby men assume authority, dominating discussions and decision-making (Kindon 1995), the decision was taken to include both men and women in the participatory mapping groups. This decision was based on my personal experience of gender relations in the Upper Bhote Koshi Valley. While men may be de jure household heads, women play a centrally important role in the household decision-making process, particularly in Tamang and Sherpa households. Even within caste households, the women are not ignored and often initiate the decision-making process by bringing issues to the attention of their husbands (see Miller 2000). I was therefore confident that the women would actively participate in a group exercise such as this.

Participants were provided with a simple base map specific to each settlement outlining the key features and landmarks familiar to the participants including the Bhote Koshi River and the Arniko Highway. The base maps were based on an enlarged version of the 1: 5,000 maps published by the SDC (1989). The mapping exercise involved four main components which were carried out in sequential order: map and area familiarisation; village features; land-use; and the identification of areas at risk from landslide activity. Information was recorded by participants using coloured pens on the base-map, or, in the case of Marmin, chalk on the school blackboard (Fig. 5.1). All information was shared visually to ensure literacy did not act as a barrier (Kindon 1995; Kesby *et al.* 2005).

Participants began by familiarising themselves with the base-map. They were then asked to add prominent features and landmarks including tracks and footpaths, places of worship, official buildings, the school and health post, and the old and new parts of the settlement, as and where appropriate. Participants went on to identify different land uses, including forest cover, grazing land, terraced farmland, paddy land and abandoned land. The final stage of the mapping exercise revealed local perceptions of landslide hazard within the settlement including areas affected by landslides in the past, present and areas which might be affected by landslides in the future. Notes were taken throughout the mapping exercise to record the conversations and discussions between participants with the aim of identifying any differences in opinion and issues which may be interesting to explore in greater detail (Kesby *et al.* 2005).

Figure 5.1 Participatory mapping a) Preparing hazard a hazard map in Chaku b) A conversation with a yak farmer who drew a simple sketch map in the earth to illustrate the cause of the 1996 Larcha debris flow disaster.

While the local people were willing to participate, they were initially hesitant and seemed to view the exercise more as a test of their understanding, rather than a sharing of knowledge. By asking questions, for example, how the land is used and who lives where, I was able to facilitate this process. Participants seemed far more comfortable mapping this way and answering my questions rather than being given a blank piece of paper to map their village.

5.4.2 Baseline surveys and purposive sampling strategy

In the absence of village level population data in the form of a formal census, ward records or a village record book, it was necessary to undertake a baseline survey to gather basic socio-economic data about each household within the case study settlements including caste/ethnic group; gender and age of the head of the household; household size; migration history; number of school aged children in fulltime education; landholdings; main sources of cash income; and whether the household had been directly affected by a landslide. Detailed notes were taken throughout with the aim of identifying 'information rich cases' for further investigation.

A purposive sampling strategy was adopted which involved me, as the researcher, making a judgement as to which households to include in the sample (Nichols 1991; Robson 2002). Concerned with depth rather than breadth, I was not seeking a statistically valid sample, but I wanted to ensure that the population as a whole was represented, for example, the different caste/ethnic groups, household poverty levels[2] and so on. A sampling strategy was therefore devised (Appendix 4). The 'snowball' method was also used whereby informants were asked to identify other members of the population who had a particularly interesting experience (Nichols 1991). Table 5.3 provides a summary of the 165 households surveyed and interviewed in each of the six case study settlements. Table 5.4 summarises the demographic characteristics of the respondents.

Table 5.3 Number of households surveyed and interviewed

	Settlement	*Number of households interviewed*	*Percentage of households interviewed*
On-road settlements	Chaku (incl. "4 km settlement")	36	22
	Larcha	11	7
	Kodari	20	12
	Total	**67**	**41**
Off-road settlements	Marmin	34	21
	Duguna	30	18
	Listi	34	21
	Total	**98**	**59**
	Total number of households	**165**	**100**

5.4.3 Household surveys

After extensive reading of the vulnerability assessment literature (for example, Aysan 1993; Cutter 1996; Davis 2003; Bollin and Hidajat 2006; Birkmann *et al.* 2006a), a draft survey was formulated with the aim of gathering baseline data concerning the socio-economic conditions of the case study households. Household surveys enable the exploration of possible correlations between various socio-economic characteristics such as caste/ethnicity and poverty level with exposure to landslide and debris flow hazards (Aysan 1993). The survey began with a detailed description of the household living conditions including the location of the house, the building materials used, the number of rooms, the interior of the house and the

[2] For the initial baseline survey, the household poverty level was determined by a series of proxy indicators including the type and quality of the house constructed, landholdings, food sufficiency and sources of cash income. A more thorough assessment was undertaken of the 165 sampled households. The detailed methodology is set out in section 5.4.4.

Table 5.4 Demographic characteristics of household respondents in the on-road and off-road settlements

Characteristic		*Frequency of households* *On-road*	*Off-road*
Gender	Male	26	46
	Female	41	52
Caste/ethnic group	High caste	22	12
	Low/occupational caste	10	15
	Hill ethnic	35	71
Age	<15	1	0
	15-24	12	7
	25-34	14	10
	35-44	19	22
	45-54	7	12
	55-64	7	15
	65-74	4	20
	≥75	3	12
Literacy	Non-literate	34	84
	Educated to primary level	21	9
	Educated to secondary level	6	1
	School Leaving Certificate (15 years)	3	2
	College Certificate (17 years)	3	2
Length of time living on the roadside	Always	18	88
	≥50 years	3	1
	30<50 years	0	1
	10<30 years	15	4
	5<10 years	13	2
	2<5 years	11	1
	1<2 years	4	0
	<1 year	3	1
Poverty level	Rich	4	2
	Relatively rich	23	19
	Middle income	31	40
	Relatively poor	9	34
	Destitute	0	3
Direct experience of landslide activity	Yes	30	63
	No	37	35

Source: Baseline survey, October 2006 and May 2007

presence of consumer goods such as a television or a rice cooker. The remainder of the survey consisted of a series of open and closed questions and covered the following topics:

- caste/ethnic group and religion
- the age, gender, education and economic activities of each family member
- household migration history

- household assets including land holdings and livestock
- food sufficiency/security
- sources of cash income
- family networks
- community groups
- the main and urgent needs of the household

The survey was shown to two external advisors with extensive experience of conducting household surveys in Nepal. Based on their advice, some minor changes were made to the survey. These changes were largely concerned with the phrasing of questions. Once in Nepal, the survey was discussed with livelihood experts to ensure the questions were feasible and culturally sensitive (Scheyvens and Storey 2003). The survey was piloted in the roadside settlement of Chaku to ensure the questions were clear, simple and unambiguous. A few problems did emerge, including the problem of defining the household (should you include family members who work abroad, for example); and how you record sources of cash income. Both questions were reworded and the final survey produced (Appendix 5).

5.4.4 Household poverty assessment

As part of the household survey a household poverty assessment was undertaken. A simple five-fold poverty classification was devised based on the five different types of livelihood capital identified by Carney (1998) and Ellis (2000) (Table 5.5). A number of proxy indicators were identified for each type of capital, with households classified as very rich, relatively rich, middle income, relatively poor or destitute (Tables 5.6 and 5.7).

Table 5.5 Five types of capital

Type of capital	*Description*
Natural/environmental	Land, water and biological resources that are utilised by people e.g. forest resources
Physical capital	Assets created by economic production processes e.g. buildings, irrigation canals and roads
Human capital	The labour available to the household including education, skills, and health
Financial capital	Stocks of money to which the household has access e.g. saving and access to credit in the form of loans
Social capital	Community and wider social ties on which households can rely

Source: Ellis (2000: 16)

Table 5.6 Household poverty indicators for the on-road households

Poverty level	*Capital*	*Indicator*	*Description*
Very rich	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own land at the roadside
			Own a 'pakka' house at the roadside constructed from bricks, cement and tiles with a gas or kerosene stove and a latrine.
		Landholdings/ food security	Produce food for 12 months of the year or able to buy food to meet subsistence needs
			Rent land to others
		Consumer goods	Television, DVD player, rice cooker
	Human	Labour pool	Large, skilled, healthy workforce
		Education	All children study for their school leaving certificate and have the opportunity for higher education
			Children attend private schools in Kathmandu
		Medical treatment	Able to travel for medical treatment e.g. for specialist treatment in Kathmandu
	Financial	Income	Multiple sources of cash income: • Own a large business with the capacity to hire employees • One or more family members engaged in formal employment • Own a rental property • Receive a sizable remittance from family members working outside the village
			Access to a bank account, bank loans and savings
			Act as money lenders
	Social	Community/ social ties	Network of family members within and outside the village
			Actively involved in community group(s)
Relatively rich	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own land at the roadside
			Own a 'pakka' house at the roadside constructed from bricks, cement and tiles with access to a latrine
			Gas or kerosene stove
		Landholdings/ food security	Produce food for 6≤12 months of the year
			Able to buy food during months when the household is unable to produce its own
		Consumer goods	Radio and rice cooker
	Human	Labour pool	Large, skilled, healthy workforce

Relatively rich cont.		Education	Children are educated to higher secondary level (17 years) (College Certificate Level)
			Able to travel for medical treatment e.g. to the local hospital
		Medical treatment	Income is more than the household expenditure - savings
	Financial	Income	Multiple sources of cash income: • Run a business (usually at the roadside) e.g. importing goods • One of more family members engaged in formal employment e.g. teaching, health care, VDC office • Remittance from household members working abroad
	Social	Community/ social ties	Network of family members within and outside the village Actively involved in community group(s)
Middle income	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own a small plot of land at the roadside Own a 'katchi' house with a tin roof and electricity or rent a house at the roadside with and open fire for cooking and access to a latrine
		Landholdings/ food security	Produce food for 3≤6 months Able to buy food during months when the household is unable to produce its own
		Consumer goods	Radio
	Human	Labour pool	Healthy workforce
		Education	All children attend school to secondary level (15 years) (School Leaving Certificate)
		Medical treatment	Access to medical treatment at the health post and local hospital
	Financial	Income	Income equals expenditure More than one source of cash income: • Wage labour • Remittance from household members working outside the village (this may take the form of food and clothes) • Own business e.g. small shop or local alcohol business Access to high interest loans only from wealthy villagers
	Social	Community/ social ties	Network of family members within and outside the village Member of a community group

Relatively poor	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own a basic house constructed from wood and bamboo matting on marginal/ government land or rent a room in a house
		Landholdings/ food security	Produce food for <3 months of the year May be unable to buy food during food deficit months – loans with local shop keepers are often needed
		Consumer goods	No consumer goods
	Human	Labour pool	Small, unhealthy or elderly labour pool. Children may work away and not remit funds leaving elderly members to undertake day-wage labour
		Education	All primary school ages children attend the local government school Children are educated to primary or lower secondary level only unless sponsored Boys may be educated over girls
		Medical treatment	Access to local health post
	Financial	Income	Wage labour is the main source of income Income is unreliable and less than outgoings High interest loans from wealthy villagers are the only source of credit
	Social	Community/ social ties	Family ties within the village but little/no contact with those residing outside the village May or may not be a member of a community group depending on the joining fee
Destitute	Environmental	Natural resources	Limited access to forest resources/grazing land
	Physical	Housing	Own a very basic house constructed from wood and bamboo matting on marginal/ government land or rent a room in a house No access to a latrine
		Landholdings/ food security	Do not produce any of their own food Loans are often needed to meet subsistence needs
		Consumer goods	No consumer goods
	Human	Labour pool	Very small, unhealthy or elderly labour pool e.g. an elderly person living alone
		Education	Children may be forced to work rather than attend school
		Medical treatment	No access to medical treatment
	Financial	Income	Wage labour is the only source of cash income and high interest loans only
	Social	Social ties	No other family/social ties. Cannot afford to join a community group.

Table 5.7 Household poverty indicators for the off-road households

Poverty level	*Capital*	*Indicator*	*Description*
Very rich	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own a ‘pakka’ house with a tin roof, electricity and latrine with a gas or kerosene stove
			Produce an agricultural surplus
		Landholdings/food	Let land to others
		security	Television, DVD player, rice cooker
		Consumer goods	Large, skilled, healthy workforce
	Human	Labour pool	All children study for their school leaving certificate and have the opportunity for higher education
		Education	Children attend private schools in Kathmandu
			Able to travel for medical treatment e.g. for specialist treatment in Kathmandu
		Medical treatment	Multiple sources of cash income:
	Financial	Income	• Own a large business with the capacity to hire employees
			• One or more family members engaged in formal employment
			• Own a rental property
			• Receive a sizable remittance from family members working outside the village
			• Money lenders
			Access to a bank account, bank loans and savings
	Social	Community/	Network of family members within and outside the village
		social ties	Actively involved in community group(s)
Relatively rich	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own a ‘pakka’ house with a tin roof, electricity and a gas or kerosene stove
			Access to a latrine
		Landholdings/ food	Produce food for 6≤12 months of the year
		security	Able to buy food during months when the household is unable to produce its own
			Own livestock
		Consumer goods	Radio and rice cooker
	Human	Labour pool	Large, skilled, healthy workforce
		Education	Children are educated to higher secondary level (17 years) (College Certificate Level)
		Medical treatment	Able to travel for medical treatment e.g. to the local hospital

Relatively rich continued	Financial	Income	Income is more than the household expenditure - savings Multiple sources of cash income: • Run a business (usually at the roadside) e.g. importing goods • One of more family members engaged in formal employment e.g. teaching, health care, VDC office • Remittance from household members working abroad Access to a bank account and bank loans Access to savings
	Social	Community/ social ties	Network of family members within and outside the village Actively involved in community group(s)
Middle income	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own a 'pakka' house with a tin roof, electricity and an open fire for cooking. No latrine.
		Landholdings/ food security	Produce food for 3≤6 months Able to buy food during months when the household is unable to produce its own Own livestock
		Consumer goods	Radio
	Human	Labour pool	Healthy workforce
		Education	All children attend school to secondary level (15 years) (School Leaving Certificate). Children travel and often live outside the village to attend lower-secondary and secondary school (11-15 years).
		Medical treatment	Access to medical treatment at the health post and local hospital
	Financial	Income	Income equals expenditure More than one source of cash income: • Wage labour • Remittance from household members working outside the village (this may take the form of food and clothes) • Own business e.g. small shop or local alcohol business
	Social	Community/ social ties	Network of family members within and outside the village Member of a community group
Relatively poor	Environmental	Natural resources	Access to forest resources/grazing land
	Physical	Housing	Own a 'katchi' house with a wood or thatched roof – maybe partly tin – and electricity
		Landholdings/ food	Produce food for <3 months of the year

Relatively Poor cont.		security	May be unable to buy food during food deficit months – loans with local shop keepers are often needed May own livestock
		Consumer goods	No consumer goods
	Human	Labour pool	Small, unhealthy or elderly labour pool. Children may work away and not remit funds leaving elderly members to undertake day-wage labour
		Education	All primary school ages children attend the local government school Children are educated to primary or lower secondary level unless sponsored Boys may be educated over girls
		Medical treatment	Access to local health post
	Financial	Income	Wage labour is the main source of income Income is unreliable
	Social	Community/ social ties	Family ties within the village but little/no contact with those residing outside the village May or may not be a member of a community group depending on the joining fee
Destitute	Environmental	Natural resources	Limited access to forest resources/grazing land
	Physical	Housing	Own a basic 'katchi' house with a wooden or thatched roof – may be old and in need of repair House located on government/marginal land No access to a latrine
		Landholdings/ food security	Do not produce any of their own food. No livestock. Loans are often needed to meet subsistence needs
		Consumer goods	No consumer goods
	Human	Labour pool	Very small, unhealthy or elderly labour pool e.g. an elderly person living alone
		Education	Cannot afford to send the children to primary school
		Medical treatment	No access to medical treatment
	Financial	Income	Wage labour is the only source of cash income High interest loans from wealthy villagers are the only source of credit
	Social	Community/ social ties	No other family/social ties Cannot afford to join a community group

Note: The size of the landholding is not specified as the productivity of the land was seen to vary greatly depending on the aspect, soil quality and steepness of slope. Landholdings were therefore not a reliable proxy for subsistence production/food security.

It is important to note that livelihoods can vary between households within the same wealth group. The poverty indicators should not, therefore, be viewed as a check-list, but rather a guide to some of the multiple indicators of relative wealth. For example, a landless household in Marmin with two householders in formal employment will be classified as relatively rich as would a household producing food for 12 months of the year and running a small roadside business. The proxy indicators also varied between the on-road and off-road households. For example, for the on-road households, agricultural production was not a reliable indicator of relative wealth as comparatively few households engaged in subsistence food production.

5.4.5 Semi-structured interviews: risk perception and response

A series of semi-structured interviews were conducted with the aim of understanding people's perceptions of, and responses to, landslide and debris flow hazard. Interviews enable the researcher to investigate complex behaviours and motivations and to gain insight into different opinions and experiences (Dunn 2000). They can be used to seek out the opinions of marginalised groups whose voices are rarely heard (Townsend 1995). Semi-structured interviews, whereby the researcher sets some broad questions for a discussion (Cook and Crang 1995), were deemed the most appropriate. Such an approach ensures that the objectives of the interview are met, that there is some equivalence across the interviews, whilst allowing the interviewees to raise their own issues for discussion and follow-up questions to be asked by the interviewer which both challenge and critically question the stories being told (Burgess 1992; Cook and Crang 1995).

It was necessary to find a suitable starting point for my interviews that would provide a way into a discussion on landslide hazard, risk perception and response. Such terms/ideas emanating from Western discourse may not make sense in another language or culture (see, for example, Heijmans and Victoria 2001). It is therefore necessary to translate these ideas into the everyday and find a starting point for dialogue (O'Keefe and Wisner *pers comm.*). With the first period of fieldwork scheduled for the end of the 2006 summer monsoon, and the majority of landslides occurring during the monsoon season, the monsoon conditions seemed an appropriate starting point for discussion. The 'funnelling' technique (Dunn 2000) was adopted whereby the interview began by focusing on more general issues related to day to day life followed by a more gradual movement towards the theme of landslide hazard and risk. The interview questions were divided into two parts: the first examining perceptions of hazard risk; and the second individual, household, community and government responses to landslide hazard and risk (Appendix 6).

As before, the interview questions were shown to two external advisors and livelihood experts in Nepal to ensure they were feasible and culturally sensitive. The interview questions were piloted among several householders in Chaku. My initial plan was to undertake the household surveys first and from this select a smaller sample of households to interview. However, informants seemed keen for me to complete both the survey and interview at once rather than returning to the house for a second time. This I did, although return visits were made where necessary to verify data and to follow up on matters of detail, sometimes with different household members (Fig. 5.2). A total of 67 on-road households and 98 off-road households were therefore interviewed (see Tables 5.3 and 5.4).

Figure 5.2 Conducting interviews a) with women in Marmin and b) an elder in Chaku.

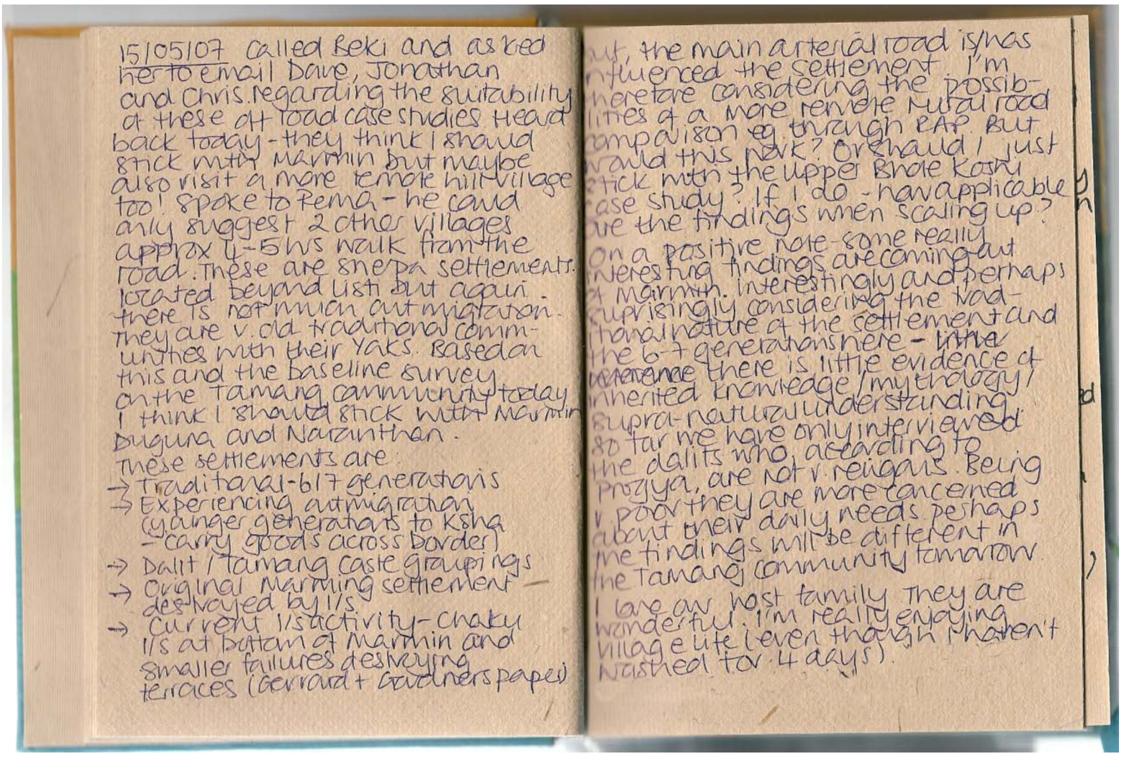
5.4.6 Oral histories

In addition to the semi-structured interviews, I conducted oral histories with 18 householders who had been directly affected by landslide activity (for an example, see Appendix 7). The aim of the interviews was to explore how landslides are perceived and understood and how they impact upon daily life in the Upper Bhote Koshi Valley. The oral histories were largely unstructured (Dunn 2000). I would begin with a few questions for example, when the landslide occurred, and then ask the respondents to describe what happened that day. Sometimes this worked well and people would give an unprompted in-depth account. On other occasions, respondents would ask me what I wanted to know and would give relatively short answers to a series of questions. This reflects, at least in part, the relationships I was able to build during my time in the field (see section 5.2). My respondents found it strange that I wanted to know everything in such great detail and, at times, my research assistants too. People also had a limited amount of time to talk to me. Off-road householders were often busy in the field from dawn until dusk, and on-road were often away from the house all day engaged in day wage labour. The women were often more accessible during the day as they ran the small hotels and shops or threshed the grain outside their houses and they seemed happy to talk to me at the same time. While the depth of the accounts varied, the oral histories added to my understanding of risk perception and response at the local level.

Figure 5.3 Conducting oral histories with Tamang and Sherpa elders in Duguna (left) and Marmin (right)

5.4.7 Research diary

A reflective research diary was kept during my time in the field. Like Storey (1997) this was used as a 'think pad' for methods, reviewing my aims and objectives, linking ideas and information and included a running 'to do' list. My research diary therefore provides a written record of my changing ideas and perspectives and has been a source of information during my write-up (Figure 5.4).



15/05/07 Called Beki and asked her to email Dave, Jonathan and Chris regarding the suitability of these off road case studies. Heard back today - they think I should stick with Marmin but maybe also visit a more remote hill village too! Spoke to Pema - he could only suggest 2 other villages approx 4-5 hrs walk from the road. These are Sherpa settlements located beyond Listi but again there is not much out migration. They are v. old traditional communities with their yaks. Based on this and the baseline survey on the Tamang community today I think I should stick with Marmin, Duguna and Narzinthan.
These settlements are:
→ Traditional - 6/7 generations
→ Experiencing outmigration (younger generations to Kasha - carry goods across border)
→ Dalit / Tamang caste groupings
→ Original Marming settlement destroyed by l/s
→ Current l/s activity - Chaku l/s at bottom of Marmin and smaller failures destroying terraces (Gerrard + Gardners paper)

ut, the main arterial road is/has nfluenced the settlement. I'm herefore considering the possibilities of a more remote rural road comparison eg through RAP. But would this work? Or should I just stick with the Upper Bhote Koshi case study? If I do - how applicable are the findings when scaling up?
On a positive note - some really interesting findings are coming out of Marmin. Interestingly and perhaps surprisingly considering the traditional nature of the settlement and the 6-7 generations here - ~~little~~ ~~evidence~~ there is little evidence of inherited knowledge / mythology / supra-natural understanding. So far we have only interviewed the dalits who, according to Pragya, are not v. religious. Being v. poor they are more concerned about their daily needs perhaps the findings will be different in the Tamang community tomorrow.
I love our host family. They are wonderful. I'm really enjoying village life (even though I haven't washed for 4 days).

Figure 5.4 Extract from my research diary

5.5 Researching landslide risk management in Nepal

The aim of the third phase of fieldwork conducted in June 2008 was to investigate landslide risk management in Nepal from different stakeholder perspectives and to explore how policy has been informed and shaped. My first research task was an analysis of current policy documents regarding landslide risk management, and associated grey literature including policy statements and reports by donor agencies. In-depth discourse analysis was beyond the scope of this study. Instead, I identified key themes in the policy documents and associated literature. The findings formed the basis of my interview and focus group questions as set out below.

5.5.1 Semi-structured interviews and focus group with technical specialists and policy makers

I conducted ten semi-structured interviews across six stakeholder groups (Table 5.8) and a focus group with technical specialists comprising geologists and engineers (Table 5.9). Participants were chosen on the basis of their experience with the research topic and were contacts I had made during my time in Nepal with whom I had informally met to discuss my research. As before, semi-structured interviews were selected as the most appropriate methodology combining a list of predetermined questions and a flexible approach to the way in which the issues were addressed (see section 5.4.5). Interviews were conducted in English and were recorded. After the interview, I documented the key themes that emerged before listening again to the interview and transcribing the sections of interest for more in-depth analysis (see section 5.8.2).

Table 5.8 Interviews conducted with technical specialists and policy makers during the third phase of fieldwork, June 2008

Stakeholder group	*Affiliation*
Government representatives	District Office, Sindhupalchok District
	Local Development Office, Sindhupalchok District
	Ministry of Local Development
Technical specialists	DFID funded Rural Access Programme
Livelihood and development specialists	Decentralised Rural Infrastructure Project, Department of Local Infrastructure and Agricultural Roads
Multilateral agencies	UNDP Nepal
Bilateral agencies	UK DFID
	JICA
Non-governmental organisations	Practical Action Nepal
	Nepal Landslide Society

Interviewing elites presents a very different set of challenges to those encountered in the village. In terms of power, it is often the interviewee who has the upper hand particularly the government officials in Kathmandu. I was often given the official standpoint on a particular issue and this was seldom critiqued by the respondent. This is a common problem when interviewing elites observed widely elsewhere (see, for example, Herz and Luber 1995; Valentine 1997).

The aim of the focus group was to bring together a group of technical specialists to discuss their experiences and thoughts about landslide risk management in Nepal (Table 5.9). The eight technical specialists involved knew each other through their affiliation to the Nepal Landslide Society and, in some cases, collaboration on previous projects. They were, however, selected to represent a range of stakeholder groups including government departments, bilateral agencies and the academy. The focus group therefore provided a forum *'for the expression and discussion of the plurality of sometimes contradictory or competing views that individuals and groups hold'* (Crang and Cook 2007: 90). The focus group was conducted in English, was held in a small hotel in Kathmandu, which provided a neutral, relaxed meeting point and lasted for approximately two hours. As the facilitator, I developed a topic guide outlining the issues to be covered enabling me to keep the group on track whilst allowing the group to explore the topic from their other own perspectives and directions. Overall, the focus groups worked well. All participants shared their experiences and perspectives, although inevitably in a focus group discussion, some more than others. Along with the semi-structured interviews, the discussion was recorded, replayed and sections of interest were transcribed for analysis.

Table 5.9 Focus group participants, June 2008

	Affiliation
Government representatives	Department of Roads
	Department of Soil Conservation and Watershed Management
Academy	Department of Geology, Tribhuvan University
	Mountain Risk Engineering Unit, Tribhuvan University
	Centre for Disaster Risk Studies, Nepal Engineering College
Bilateral agencies	DFID funded Rural Access Programme
Non-governmental organisations	Nepal Landslide Society

5.5.2 Research dissemination workshop

The final phase of the research involved a research dissemination workshop held at the International Centre for Integrated Mountain Development in Kathmandu. The aim of the workshop was three-fold:

1. to disseminate the findings from my research into landslide vulnerability in Nepal;
2. to determine if the findings from the study apply elsewhere in Nepal; and
3. to identify ways forward for future research, policy and practice.

A total of twenty four people participated in the workshop from five stakeholder groups working within the field of road construction; landslide mitigation and management; and disaster risk reduction. These included: representatives from government ministries and departments; technical specialists (geologists and engineers); livelihood and development specialists; and representatives from the multilateral agencies and NGOs. The full workshop report and list of participants can be found in Appendix 8.

Having shared and discussed the findings from my research, the group was divided into mixed stakeholder groups of four to five people to brainstorm areas for future research, policy and practice (Fig. 5.5). Groups were encouraged to share their ideas in a feedback session which fed into a plenary discussion on landslide risk reduction in Nepal which addressed a series of key questions. The workshop report was circulated participants for their comments after the event.

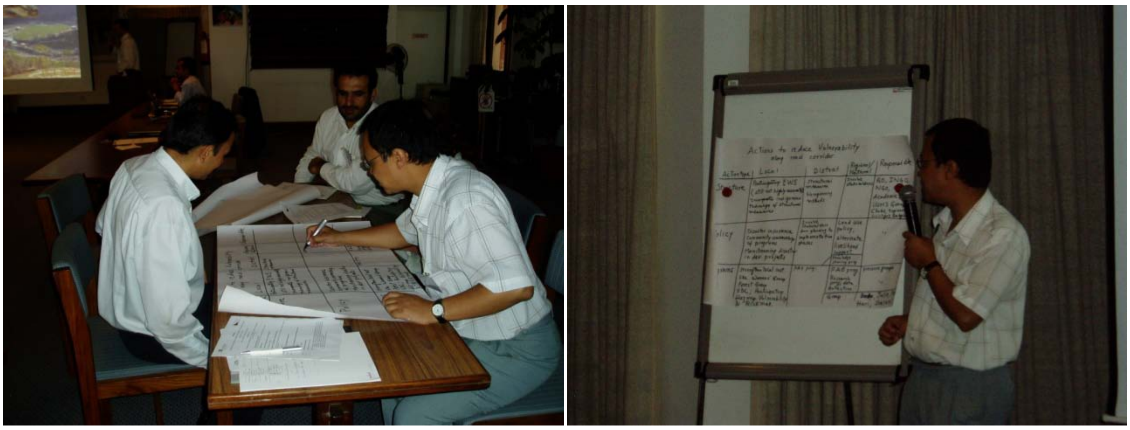


Figure 5.5 Research dissemination workshop - small group discussion and feedback session

5.6 Reflections on the research process

5.6.1 The research context: doing research in Nepal

Undertaking research in Nepal was challenging given the ongoing political situation. Shortly after completing my reconnaissance field visit in April 2006, violence broke out in Kathmandu.

Pro-democracy activists defied a state curfew to protest against the King's direct rule (Fig. 5.6). Protests against the King were common, with regular *'bundhas'* (national strikes) called by the Maoists and the opposition parties. While Westerners were not a target the protests frequently became violent and I was strongly advised to avoid public gatherings. The *bundhas,* which could go on for several days, saw the closure of roads, shops and businesses and we were often advised to stay inside. Such events made planning difficult with journeys frequently interrupted and abandoned; I often found myself unable to leave or return to the Kathmandu Valley.

As noted by Pettigrew *et al.* (2004), while much early research in rural Nepal tended to marginalise the state in their analysis, in the last few years the situation has changed and it has become impossible to ignore issues of politics and the state. My reconnaissance and first field visit were undertaken during the height of the Maoist Insurgency. The peace agreement was signed between the Seven Party Alliance Government and the Maoists ending the decade long civil conflict at the end of my first major field visit in November 2006. My second field visit coincided with the elections for Nepal's Constitutional Assembly, that had been postponed on three separate occasions. My final visit to Nepal occurred in May/June 2008 shortly after the April elections, which saw the Maoists win a majority. With the Monarchy abolished under the new Constitutional Assembly, I found myself arriving in a Kingdom and leaving a republic. This undoubtedly had an impact on my research, not only from a logistical perspective, but also in the manner in which the rapidly changing political landscape percolated into the views and outlooks on the communities with which I was engaged.

Figure 5.6 Protests in Nepal, April 2006. Source: Paula Bronstein, Getty Images and BBC News.

5.6.2 Ethical issues and dilemmas

Research in the developing world can give rise to a plethora of ethnical dilemmas, many of which relate to the power gradient between the researcher and the researched, knowledge generation, ownership and exploitation (Scheyvens *et al.* 2003). I have tried to make it clear when ethical issues arose and the decisions that I made in order to ensure that the research process was as sensitive to these as possible. I tried to follow Sidaway's (1990) useful guidelines: first, make no false promises; second, beware of unintended consequences of your actions; and third, share the results of your research. When introducing the research I made it clear to participants that this was academic research and was in no way linked to the government, the Maoists or a development NGO. I made it clear that they were unlikely to see any immediate benefit from the research but that I wanted to share the findings with practitioners in Kathmandu with the aim of helping in the future. Whilst I tried 'to do no harm' we can never know the full consequences of the research (Madge 1997). But, the most difficult guideline to follow was sharing the findings. I was keen to return to the Upper Bhote Koshi Valley but I did not – and still do not – know what I have to share that would be useful or of value to the case study communities with whom I worked. It was far easier to organise a research dissemination workshop for technical specialists and policy makers in Kathmandu, for example, in the hope that my findings might influence practitioner thinking or even policy. Whilst useful, I am conscious of the need to feed back to the communities themselves in order to avoid what Townsend (*pers comm.*) terms "vacuum cleaner research". I continue to ask myself who will gain more from the research – them or me? Uncomfortably, on reflection it is likely to be me (see England 1994; Katz 1994).

5.6.3 Research and compromise

During fieldwork a number of compromises had to be made. Firstly, my research was conducted over four field visits, the advantage being that I could reflect on my findings between visits, analyse the data gathered and, where necessary, reformulate my research questions. This was particularly useful after my first phase of fieldwork in Chaku, Larcha and Kodari. However, while I did not set out to undertake an in-depth ethnographic study, I acknowledge that it was difficult to build a relationship of trust with my informants over the relatively short periods of time that I spent in the field.

My research assistants, Yubaraj and Bhawana, were unable to accompany me on my second field visit; Yubaraj had taken a job with the Asian Development Bank and Bhawana had married. Despite being conscious of the need for continuity, it was necessary to recruit two new field assistants for the second phase of fieldwork. This meant a certain degree of back tracking, spending time with my new research assistants to explain the nature of the research. I was fortunate that Yubaraj helped me with the research training but, nonetheless, having a different research team meant it was difficult to discuss how the research was evolving as a whole.

For the first period of fieldwork I stayed in commercial accommodation in the Upper Bhote Koshi Valley. The decision not to live in the case study villages was a personal choice reflecting my own concerns regarding the ongoing conflict and my own physical health having been plagued with a stomach upset during my reconnaissance visit. Of course there were trade-offs to this: living within one's research site gives a much greater appreciation of issues and a context for data and it can also result in acceptance and trust which undoubtedly aids the research process (Leslie and Storey 2003). This was mitigated to some degree by spending extended days in the field, usually 7am until 7pm, but overall I followed the advice of Leslie and Storey (2003): *'your principle aim while in the field is to carry out your research aims to the best of your abilities so choose a place to stay which allows you to do this most effectively, and accept limitations'* (p. 89).

Finally, conducting the research at a politically sensitive time meant there were certain topics I was advised to avoid. For example, direct questions about the impact of the insurgency, people's political affiliation and so on. I consider this to be a significant limitation of this study. Undoubtedly, the insurgency has impacted upon people's vulnerability but this was an area I was unable to explore. The few available ethnographic accounts of the insurgency that exist (Pettigrew 2004; Schneiderman and Turin 2004) highlight just how difficult it is to illicit information regarding the conflict, even when the researcher has a long and established relationship with the village community (see, for example, Pettigrew 2004). I will return to this in Chapter 6.

5.7 Data analysis

5.7.1 Representation of knowledge

The representation of knowledge is always problematic, contingent and subjective (Graham 1997; Rose 1997; Jazeel and McFarlane 2010). The villagers in my research are speaking twice removed. First of all their words are being translated by a research assistant into English, which I am then recording. And then these words are being interpreted a second time through my understanding of Nepali and Tamang/Sherpa culture. Responses to interview questions were often plagued with what could normally be viewed as direct contradiction: a respondent may give a supra-natural explanation for a particular landslide but later say that all landslides are caused by the monsoon rains. Forming a narrative around this is challenging and I have constantly questioned my interpretation and representation of participants' knowledge. Using multiple methods (semi-structured interviews, oral histories and participatory methods) helped me to explore these ideas in greater detail. I do not believe there is a right or wrong answer but instead I have tried to tease out the complexity in people's responses.

While the interviews with elites were conducted in English, concerns regarding the representation of knowledge remain. Misunderstandings are common when interviewing in different cultural contexts because of slight differences in meanings (Valentine 1997). It is important, therefore, to acknowledge that the people in my research are speaking through my interpretations and my understanding of Nepali culture. I tried to overcome the influence of this by approaching the interviews and data generated with an open and reflexive mind, whilst trying to apply a consistent methodological framework as and where possible.

5.7.2 Analysing the quantitative and qualitative data

SPSS was used to analyse the data generated from the household surveys. As previously noted in section 5.4.2, this was not a statistically representative sample. I was, however, able to look for trends in the categorical data collected from the 165 interviewed households. The findings are presented as descriptive statistics. A 'grounded theory' approach was adopted to analyse the interview and focus group material (Crang 1997). The material was re-read and a series of themes or 'open codes' were noted. From here a series of sub-themes or sub-codes were identified. These included 'emic' codes, codes used by the informants themselves e.g. God or deity; and 'etic' codes, codes I assigned to describe events and attribute meaning and theories, for example, 'supra-natural explanation'. The grounded theory approach was applied to the household interviews, oral histories and the semi-structured interviews undertaken with institutional representatives and 'experts' in Kathmandu.

5.8 Summary

This chapter has discussed the research methodologies used to address the questions outlined in Chapter 1. Given the complex and diverse socio-cultural setting of my study site, combined with the interaction of landslides with the social landscape, a variety of methods were appropriate to obtain depth of understanding. In this chapter I began by setting out my epistemological position before reflecting on my own positionality and how this affected the research, a stance I attempted to retain throughout my research. This was followed by an overview and justification of the methods used and analysis employed, based upon previous research of a similar nature conducted elsewhere. Finally, I reflected on a series of ethical issues that emerged. Like Adams and Megaw (1997), I wanted to present an honest and open account of my research including the challenges and compromises that had to be made in undertaking this. I remain mindful that this study has attempted to tread new ground, both geographically and conceptually, by aiming to gain insight into the role of community level vulnerability in a dynamic, populated mountain environment. The following chapter outlines the demographic, social and economic context of the six case study settlements, derived from the methods presented above.

Chapter 6

The Changing Geographies of Risk and Opportunity

6.1 Introduction

It is frequently argued that increasing population pressure, unequal access to land, lack of employment opportunities and poverty all force people to settle in high risk areas (Burton *et al.* 1993; Wisner *et al.* 2004). This poverty-induced forced migration makes the poor, in particular, vulnerable to disasters (Lein 2000). While such a causality may seem self evident, empirical evidence is lacking. Drawing on secondary literature and primary material, including key informant discussions, household surveys, semi-structured interviews and oral histories, this chapter presents an overview of settlement history and rural livelihoods in the Upper Bhote Koshi Valley with the aim of understanding who occupies landslide prone areas and why. In particular, the chapter seeks to address the following questions:

1. What are the factors and forces shaping current day settlement and land use patterns in the Upper Bhote Koshi Valley?
2. How have these patterns changed through time?
3. What are the changing risks and opportunities?
4. Where do landslides sit within this context of varied risks and opportunities?

Drawing on Wisner *et al.*'s (2004) pressure and release model (see Chapter 3), this chapter will begin by examining the root causes giving rise to present day vulnerability. The chapter will then introduce the off-road and on-road settlements in turn and the migration patterns in the Upper Bhote Koshi Valley. This will be followed by a detailed discussion of the 'push' and 'pull' factors influencing the occupation of landslide prone areas. Finally, individual case studies are presented providing an insight into the complex decision-making processes behind the human occupation of landslide prone areas.

6.2 The Upper Bhote Koshi Valley: A historical overview

Like Wisner *et al.* (2004) and Bankoff (2003; 2004), I argue that in order to understand present day vulnerability, a historical perspective is needed. I begin, therefore, by examining historical migration and settlement patterns, and the political economy in the Upper Bhote Koshi Valley.

6.2.1 Migration and settlement patterns in the Upper Bhote Koshi Valley

Despite the historical remoteness of the region, the settlements in the Upper Bhote Koshi Valley are far from the small, homogenous, stable, or even static communities one might expect. Instead, we find a dynamic, lived in environment with a long history of mobility and migration. Initially inhabited by Mongoloid groups of Tibeto-Burmese origin, the area was later settled by caste Hindus from the Indo Aryan south. The gradual conversion from transhumance to sedentary agriculture driven largely by state intervention resulted in extensive landscape modification and population growth. A long history of trans-Himalayan trade and later a growing remittance economy[1] from seasonal employment in the Terai, India and, more recently, the Middle East challenges the sedentarist paradigm. However, it was the construction of the Arniko Highway in the 1960s which has driven the most recent wave of mobility and migration: that is, outmigration from the hills and the establishment of roadside settlements.

Archival research undertaken by Mahat *et al.* (1986b) suggests the first inhabitants of what is now Sindhupalchok District were the Kiratis, a Mongoloid group of Tibeto-Burmese origin. The Kiratis were pastoralists and are believed to have practised shifting cultivation. The Tamangs (also of Tibeto-Brumese origin) succeeded the Kiratis in Sindhupalchok and are believed to have been the first settlers in the Upper Bhote Koshi Valley specifically, with Tamang leaders tracing their settlements back to the mid 1700s (CEAMP 2005) (Table 6.1). Like the Kiratis, the Tamang people were transhumant pastoralists and grazed land in the high hills.

The Sherpa are understood to have arrived in the Upper Bhote Koshi Valley around the same time as the Tamang, approximately 250 years ago (Interview with elders, October 2006). While there are no written records of their migration to the valley, the Sherpa have long been associated with the trans-Himalayan salt trade, acting as the middlemen in the trade between Tibet and the low lying regions to the south (von Furer-Haimendorf 1975). Contemporary elders interviewed in the Upper Bhote Koshi Valley recall the exchange of goods between

[1] Remittance refers to the transfer of funds from household members working away from home.

Jalbire (a trading centre to the south of Barabise) via the Upper Bhote Koshi Valley to Tibet. As one elder explained:

> *"Maize, wheat, rice and other food crops like pumpkins, cucumbers and fruits were exchanged for salt. Two pathi* [approximately 8 kg] *of crops was exchanged for 1 pathi* [approximately 4 kg] *of salt."*
>
> (Male elder, Chhetri, 72 years, non-literate)

Table 6.1 Dating the arrival of different caste and ethnic groups in the Upper Bhote Koshi Valley

	Caste/ethnic group	*Caste/ethnic sub-group*	*Origin*	*Approximate date of arrival*
Hill tribes	-	Tamang	Tibeto-Burman	c.1750s
		Sherpa		c.1750s
		Rai		c.1750s
Partbatiyas[2]	High caste	Brahmin	Indo-Aryan	c.1800s
		Chhetri		c.1800s
	Occupational caste	Kami		c.1800s
Newars	High caste	Shrestha	Indo-Aryan	c.1800s

Source: Interviews, October 2006

Salt was traded by the Newar, Chhetri and Sherpa peoples in the Upper Bhote Koshi Valley, often over long distances (Interview with elders, October 2006). But trade was not confined to crops or goods of Nepali or Tibetan origin, with Nepal exporting goods from India and overseas and importing from Tibet goods originating in China (Plant 1964). Until the British opened up the way to Lhasa via Sikkim at the beginning of the twentieth century, most of the trade between India and Tibet passed through Kuti (via the Upper Bhote Koshi Valley) and Kyirong (via the Trisuli Valley in neighbouring Rasuwa District) (Stiller 1973). The Upper Bhote Koshi Valley was, economically and strategically, an important trade and communication corridor through Central Nepal.

The close proximity of Sindhupalchok to the Kathmandu Valley made the district vulnerable to Indo-Aryan penetration. Discussions with elders suggest the Newars and the Parbatiyas arrived more than 200 years ago (Table 6.1). The Newars (merchants and traders) migrated from the nearby trading posts of Sankhu and Dolokha (which are located on the trade route between Kathmandu and Lhasa) and from the ancient Newar kingdoms in the Kathmandu Valley to take advantage of the business opportunities associated with the salt trade. The

[2] 'Partbatiyas' are Nepali speaking mountain peoples including the high caste Brahmins and Chhetris and the occupational caste groups including the Kami (metal workers) and Damais (tailors).

Brahmins and Chhetris followed, along with the occupational caste groups, who were employed by the high castes as blacksmiths, tailors and cobblers.

Settlements in the hills

Village elders in the hill villages of Marmin, Duguna and Listi can trace the history of their settlements back 12 to 14 generations (approximately 250 years). Kanglang, Kaule and Listi in Listikot VDC are considered to be the oldest settlements in the Upper Bhote Koshi Valley and were first settled by migrant Tamang and Sherpa clans from Tibet. The subsequent arrival of the Newars and the establishment of the Newari Kingdom in Listikot can be linked to the subjugation of Sindhupalchok District in the 18th century. The flat land in Listi was ideal for settlement construction and the trans-Himalayan salt trade provided business opportunities for the migrant population (Table 6.2). The presence of copper and iron ore deposits in Listikot VDC was a further draw. As noted by Mahat *et al.* (1986b), the importance of indigenous metallurgy increased dramatically with the rise of the Gorkha state in the eighteenth century and the subsequent wars with China (in Tibet) and Britain (in India). With the army requiring arms and munitions, the procurement of mineral supplies was of key importance to the state (ibid).

Table 6.2 Factors influencing the establishment of settlements in the Upper Bhote Koshi Valley

Factor	*Details*
Physical	Natural resources including copper and iron in Listikot VDC
	Gold mining in Phulpingkatti VDC
	Available land for cultivation
Social	'Open-border' between Nepal and Tibet
Economic	Trans-Himalayan trade
Political	Close proximity to the Kathmandu Valley
	Key area of defence during the Nepal-Tibet war

Source: Interviews with village elders, October 2006 and May 2007

Elders interviewed in the case study villages explained how their forefathers migrated from Listikot and established settlements across the Upper Bhote Koshi Valley. Villagers in Marmin and Duguna are descendents of the early settlers in Listikot and of migrant hill tribes from eastern Nepal. Marmin is a predominantly Tamang settlement and has been occupied by Tamang households for more than 12 generations. Yarmasing and Patikuna (sub-settlements of Duguna located near the ridge top) were first settled 12-13 generations ago by the Sherpas in the early 1700s; while the valley bottom settlement of Duguna has been the home of high caste Chhetris for more than 10 generations. The occupational castes (blacksmiths or *'kami'*) settled in Marmin and Duguna approximately 100 years ago but there are no family histories detailing where they migrated from or how they came to settle in the Upper Bhote Koshi Valley specifically. The location of the Kami sub-caste in Sindhupalchok is most likely linked to the presence of iron ore deposits required for their metal work (Graner 1997).

Settlements in the valley bottom

Village elders interviewed in the roadside settlements of Chaku, Larcha and Kodari can trace the history of the settlements in the valley bottom back three to four generations. It was the Tamang and Sherpa peoples who began cultivation in the valley bottom more than 100 years ago. In Chaku, the first house was constructed approximately 120 years ago by Tamangs who migrated from the top of Marmin hill and cleared the forest land for agriculture. The Newars (the high caste merchants and traders) settled in Chaku just after the Tamangs around 100 years ago to take advantage of the business opportunities associated with the Himalayan salt trade. Similarly, Larcha was first settled in the 1940s by the Sherpa and Tamang peoples from Duguna village who cultivated the land adjacent to the Bhairab Kunda Stream in the valley bottom. The history of Kodari is more difficult to ascertain as the original Sherpa settlers abandoned their land following a landslide around 65 years ago. However, the clearance of the forest in the early 1900s in the valley bottom is probably accurate in broad outline. The settlements of Chaku, Larcha and Kodari were therefore established before the construction of the highway in the mid 1960s.

6.2.2 The political economy

Until the mid 1700s, Nepal (as we now know it) was divided into sixty principalities or petty hill states (Blaikie *et al.* 2001). The close proximity of Sindhupalchok to the Kathmandu Valley and its strategic importance for trans-Himalayan trade, has long made the district vulnerable to Indo-Aryan control. During the later medieval period (16^{th}-17^{th} century), the Newar Kings of the Kathmandu Valley subjugated the trade routes between Kathmandu and Tibet which passed through Sindhupalchok. Later, the Gorkhalis (who had established a Hindu Kingdom in the western hills) began to consolidate and extend their control across the petty states. They subjugated Sindhupalchok in c.1745 (Seddon 1987) with the intention of controlling the trade routes and ultimately conquering the Kathmandu Valley which they did in 1769. The Gorkha state continued to expand and by the end of the eighteenth century, *'virtually the entire area that is now Nepal had been incorporated into a loosely articulated hegemony that may be attributed as a tributary state'* (Blaikie *et al.* 2001: 27). The ruling classes were the high caste Hindu immigrants: Brahmin, Chhetri and Thakur.

The expansion of Gorkha resulted in a conflict of power between the hill ethnic groups (the indigenous population of Sindhupalchok), and the newly emerging Hindu state. With the land as its main resource, the state began to extend control over the land, the peasant farmers who inhabited that land and the natural resources found there. The aim of the state was to appropriate revenue, in the form of taxes from farmers and traders and to do this it was necessary to maintain internal security and order (Seddon 1987). This process of territorialisation (cf. Rigg 2007) resulted in the state bringing all tribal lands under a uniform system of tenure, akin to freehold and known as *'raiker'* (Mahat *et al.* 1986b). *Raiker* has been described as a system of 'state landlordism' under which the rights of an individual to the utilisation of the land were recognised by the State as long as taxes were paid (Regmi 1963).

The Gorkha State began to codify the use of space. *Raiker* land could be assigned to others either temporarily in lieu of a salary (e.g. in the form of a *birta* or *jagir* grant) or permanently for the support of a religious institution (e.g. *guthi* land endowments) (Table 6.3). Sindhupalchok was a popular area for land grants due to its close proximity to Kathmandu and *birta* grants in particular were common in the Upper Bhote Koshi Valley with much of the land in the case study settlements of Chaku, Larcha, Kodari, Marmin and Duguna under *birta* tenure. As one village elder from Chaku recalled:

> *"*[b]*efore the implementation of Land Reform, most of the agricultural, grazing and forest land* [in the Upper Bhote Koshi Valley] *was under the control of Colonel Faud Singh and Regional Judge Prakash Bahadur. They employed a Jimmawal* [a local land tax collector] *who collected money, crops, fruit and butter as land tax. Chhang Bu Sherpa collected the land tax in Marmin."*
> (Male elder, Newar, 73 years, non-literate)

Table 6.3 Land allocations made by the state

Land assignment	*Description*
Jagir	Land assigned to officials and other government employees in lieu of their salaries. All benefits of the land were accrued to the holder. The grant was valid for as long as the official served the state.
Birta	Land (including forest) assigned to a noble in recognition of services to the state. All benefits of the land were accrued to the holder. The grant was valid until it was recalled or confiscated.
Guthi	Land endowments made to temples and monasteries.

Sources: Mahat *et al.* (1986b: 329-330) and Joshi and Mason (2007: 400-401)

Discussions with residents suggest the majority of land in Listikot was owned by a '*Talukdar*' (a private land holder) but was later assigned to Listikot temple in the form of a *guthi* land endowment. According to local people interviewed, more than 60% of land in Listikot VDC is now *guthi* or temple land. Villagers farming the land pay a certain percentage of their crops to the *guthi* (Listikot Temple).

According to the elders interviewed, the *birta* system continued in the Upper Bhote Koshi Valley until 1978 when representatives of the state visited the Valley and transferred the land rights of the *birta* holders to the peasant farmers cultivating the land. Villagers make a clear distinction between the situation prior to, and after, Land Reform suggesting the State policy regarding the reallocation of land was, to some extent, effective in the Upper Bhote Koshi Valley. However, not everyone benefited from the reallocation of land. Those who were familiar with the Government's Land Reform policy paid their land tax and registered the land belonging to others in their own name. Those who did not understand the land reform policy failed to register their land at all.

While the emergence of the Panchayat Political System in 1991 saw the reallocation of some of the remaining land held by nobles and servants of the state, there are examples where land endowments were not reallocated, the impact of which is still felt today. Mahat *et al.* (1986a) cites the example of the 10,000 ha of Marmin-Kalinchok forest (approximately one third of the forest) in the Upper Bhote Koshi Valley granted to a Colonel in 1948. This *birta* was granted on a life time basis and should have reverted to the government on the death of the beneficiary. However, the actual area under *birta* control extended to more than 35,000 ha (much of the forest area) and the grant was not relinquished on the death of the assignee. Only recently has the forest been reverted back to state owned land.

6.2.3 Summary

This brief historical overview has introduced some of the factors and forces shaping current settlement and land use patterns in the Upper Bhote Koshi Valley. The principle factors include trans-Himalayan trade and the 'open-border' between Nepal and Tibet which resulted in the migration of hill tribe groups from the north and caste Hindus from the south. Table 6.4 provides a summary of the key economic, demographic and political processes in Nepal that shape the present day vulnerability context.

The next section addresses the lack of contemporary information on existing population distributions. It draws on the household surveys undertaken during the 2006 and 2007 field seasons to provide a descriptive account of the current day demographic characteristics of the

Table 6.4 Economic, demographic and political processes giving rise to present day vulnerability in Nepal

	Physical/environmental characteristics	*Demographic characteristics*	*Economic characteristics*	*Political characteristics*
Before 1769 (pre-Gorkhali period)	First settlers practiced shifting cultivation Farming practices based largely on transhumance/ pastoralism Gradual shift towards sedentary agriculture Introduction of irrigated rice cultivation in the valley bottom Limited environmental stress; low population densities; abundant land	First settlers were the Kiratis (c.900 AD) Arrival of the Tamang and Sherpa ~400 years ago Arrival of the high caste Hindu immigrants including the Brahmins and Chetris ~300 years ago Arrival of the Newars ~400 years ago. Early population growth linked to an increase in agricultural production.	Tribal areas: subsistence farm economy based on transhumance; barter trade with Tibet Hindu dominated areas: land and labour viewed as the dominant resource. Clearance of forest land for agriculture Trans-Himalayan trade	Approximately 60 autonomous petty hill states (Hindu dominated) Egalitarian clan based tribal land Newar rulers in the Kathmandu Valley subjugated the trade routes (c.1600-1700s) The Gorkhalis subjugated Sindhupalchok and the trade routes (c.1745)
1769-1846 (Gorkhali Period)	Hills - opening up of forest land for agriculture Advanced state of deforestation reached by the late 1700s Maximised the limited carrying capacity of the land Reclamation of agricultural land in the Terai	Population growth Gradual encroachment of indigenous tribal lands Official policies encouraging immigration into Nepal from Tibet and India to encourage land reclamation and settlement	Economy in the hills was still dominated by subsistence agriculture and barter trade Initial increase in agricultural productivity in the hills Agricultural expansion in the Terai and the export of crops to India	Expansion of Gorkha control and the unification of the ‘petty states’ State intervention focused on agricultural expansion Revenue generation through land taxation increased c.1830s

1769-1846 (Gorkhali Period) Continued		Increase in sedentary agriculture linked to the introduction of maize Land allocated to officials and servants of the state leaving limited land for the peasants to cultivate Enhanced land tax resulted in outmigration from the hills to India (c.1830)	Establishment of the timber trade in the Terai	Land grants made in increasing numbers Little emphasis placed on improving productivity or sustainable resource management 1814 -1816 British-Nepal War - Nepal became a political dependency or 'semi-colony' of the British Nepal remained largely autonomous with British control extending to foreign and trade policies only
1846-1950 (Rana Period)	Local responsibility for forest management emerged in the hills independent of government policy Deforestation in the hills ceased as the remaining resources were necessary for the hill farming system The exploitation of forest gained momentum in the Terai	Continued population growth Food shortages in the hills Unequal access to land Pressure on land and the absence of employment opportunities resulted in outmigration from the hills to the Terai, Bengal, Assam, Burma, Darjeeling and elsewhere By 1930 one Nepalese-born person in twenty was living in India Introduction of welfare measures	Focus remained on the physical expansion of subsistence farming Impoverishment of the peasant majority Increased revenue from timber sales and the annual value of trade increased six fold by 1900 No industrial development or investment in the manufacturing sector Economic stagnation	Emergence of the Rana Dynasty and a regime of 'Hinduisation' Evidence of state corruption (25-50% of state revenue went directly to the Ranas) Minimal state intervention Focus on agricultural expansion mainly in the Terai Tax exceptions on any newly-reclaimed land continued (3 years exemption in the hills and 5 years in the Terai to promote

1846-1950 (Rana Period) Continued			Trade deficit	immigration) 1923 Nepal became independent from the British
1950-present	Continued forest exploitation in the Terai for agriculture and timber Limited environmental change in the hills Links made between deforestation, agricultural expansion and an assumed acceleration in soil erosion and landsliding in the Middle mountains have been challenged	Despite population growth the mountain and hill areas remain sparsely populated Limited land reform Outmigration continued Population pressure in the Terai resulting in a reduction in the size of land holdings Focus on welfare issues and education	Nepal remains an agrarian economy with a focus on subsistence production Households increasingly dependent on off-farm income Failure of the state to stimulate economic growth Failure of agricultural development No notable industrial development Closure of the Nepal-China border in 1959 - decline in trans-Himalayan trade Trade agreements with India which undermined and replaced local production and flooded the market with Indian commodities	Fall of Rana family Series of weak ministries 1962 introduction of the party-less panchayat political system "grassroots development" State initiation of: • Economic planning • Land reform • Road provision Attempts at land reform (1960s), natural resource management etc. Rise in political consciousness - emergence of the people's movement 1990s - end of the Panchayat political system and the restoration of multi-party democracy 1996 – People's War

off-road (Section 6.3) and on-road (Section 6.4) settlements. An awareness of the difference between the social contexts of the on-road and off-road settlements is key to understanding the factors affecting social vulnerability and the position of landslides within community risk perception and response. As a result, the section goes into some depth to provide the social vulnerability context vital for the subsequent discussion.

6.3 Off-road settlements

Placing the household at the centre of my analysis, the aim of this section is to describe 'normal' life in the off-road settlements. Demographic characteristics including population composition, migration patterns, household poverty, land ownership, food production, and the off-road economy are discussed. The impacts of landslide activity within this social context are then explored.

6.3.1 Population overview

The population of Marmin, Duguna and Listi is comprised of five caste/ethnic groups: Chhetri, Newar, Kami, Sherpa and Tamang (Fig. 6.1). The Sherpa and Tamang hill tribes dominate interspersed with caste Hindus. There are two communities of occupational caste Kamis (blacksmiths): one in Marmin and one in Duguna; and a significant Newar population in Listi. Table 6.5 provides an overview of the sampled off-road households by caste/ethnic group.

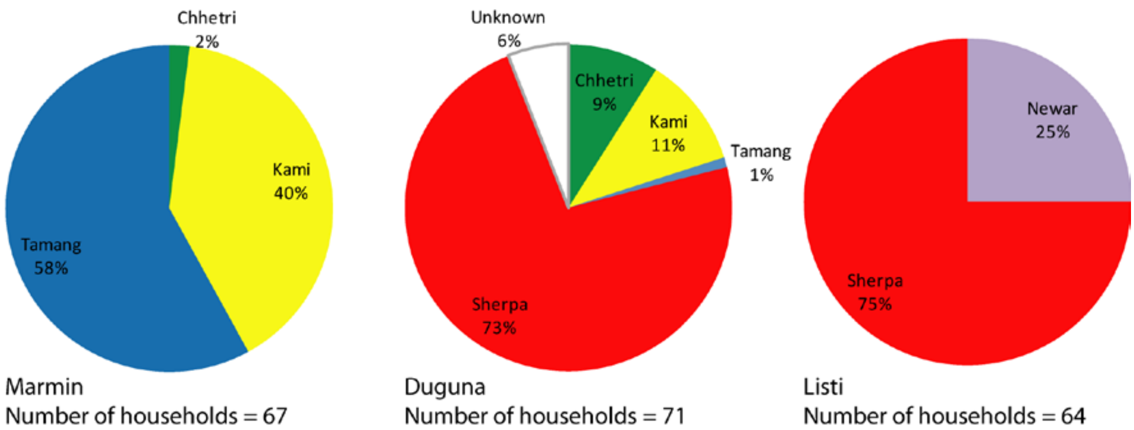


Figure 6.1 Population distributions by caste/ethnic group in the off-road settlements of Marmin, Duguna and Listi. Source: Baseline surveys, May 2007.

Table 6.5 Sampled off-road households in Marmin, Duguna and Listi by caste/ethnic group

Caste/ethnic group	*Sub-group*	*Frequency of households*
High caste	Chhetri	4
	Newar	8
Low/occupational caste	Kami	15
Hill tribe	Sherpa	48
	Tamang	23
Total		98

Source: Household surveys, May 2007

The distribution of the sampled population by age is relatively even (Fig. 6.2). Children often stay in the village with their grandparents to attend primary school as indicated by the high number of 5-14 year olds. The comparatively small sample population in the 15-44 age bracket reflects the high levels of selective outmigration of young people, particularly young men as indicated by a greater number of females in the 15-44 age bracket.

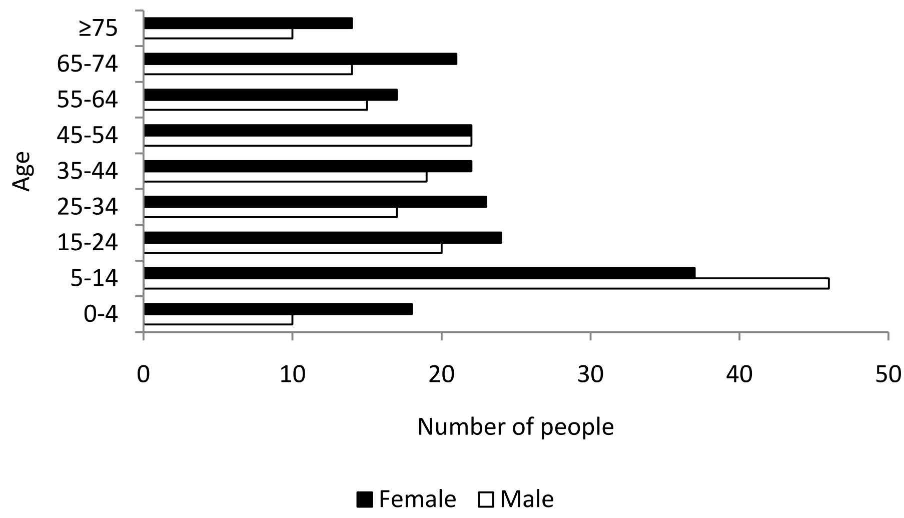


Figure 6.2 Sampled off-road population by age and sex

Source: Household surveys, May 2007

The mean household size in the off-road settlements is six, which includes all household members even those residing outside the village (Table 6.6). The mean household size, based on the number of people who reside in the village and share the kitchen is four (Table 6.6).

Table 6.6 Frequency distribution of household size

Household membership	*Frequency of households*	*Family members sharing the kitchen*	*Frequency of households*
1	2	1	9
2-3	13	2-3	40
4-5	31	4-5	30
6-7	30	6-7	13
8-9	17	8-9	5
10-11	3	10-11	1
≥12	2	≥12	0
Total	98	Total	98

Source: Household surveys, May 2007

Of the 98 households sampled, 29 are permanently headed by women, the majority of which are widows living with their married sons and grandchildren. In addition, two households are effectively headed by women as their husbands are working and residing outside the village, returning for one or two days per month.

6.3.2 Migration and movement

In general, the people in the hill villages have lived there all their lives; 90% (n = 88) of the household heads in the survey were born in Marmin, Duguna and Listi (Table 6.7). Of the ten who migrated there, only one household head migrated from outside the Bhote Koshi Valley. This is the high caste headmaster in Marmin who migrated from Solukumbu District in Eastern Nepal and who was allocated Marmin School by the Department of Education. For the remaining nine households, the acquisition of land through inheritance or as a gift was the main reason for the migration along with landslide activity.

Table 6.7 Frequency distribution of migrant household heads by year since migration

Years since migration	*Frequency of households*
6 months < 1 year	1
1 < 2 years	1
2 < 5 years	2
5 < 10 years	3
15 < 20 years	1
20 < 30 years	1
30 < 40 years	1
Total	10

Source: Household surveys, May 2007

However, links to areas beyond the hillside are very important; the survey showed that of the 98 sampled household, 69 have family members residing and working outside the village (Table 6.8). Some go off to work for a year or more while others leave the village periodically for weeks or months at a time. Forty five percent (n = 44) have family members living and working in the roadside settlements of the Upper Bhote Koshi Valley while 26% (n = 25) of the sampled households have family members working in the capital, Kathmandu. Forty percent (n = 39) of the sampled off-road households have family members working abroad either cross-border in India and China or overseas in the Middle East or elsewhere in Asia, most often Malaysia.

Table 6.8 The location of household members working outside Marmin, Duguna and Listi

Location	*Frequency of households*
Roadside settlements, Upper Bhote Koshi Valley	44
Kathmandu	25
China	1
India	19
Asia other	4
Middle East (Qatar, Oman, Quwait)	15

Source: Households surveys, May 2007

6.3.3 Household poverty level

For many in the hill villages, relative poverty levels are not as considerable as might be expected (see, for example, Blaikie *et al.* 2001). It is perhaps surprising to note that 62% (n = 61) of the sampled off-road households have been classified[3] as middle income households or above and are able to meet their own subsistence needs through agricultural production substituted, where necessary, with cash income. For the 41% (n = 40) of middle income households this includes wage labour on other farms, portering and house construction. In some instances, the importance of links with locations outside the hill communities is again shown to be important with remittance from family members working outside the village identified as a valuable income source. This is discussed further in Section 6.3.5. The 19% of sampled households classified as relatively rich and two households classified as very rich, are able to meet their subsistence needs though agricultural production and a range of income generating activities including business income, formal employment and remittances. For

[3] The methodology used to determine household poverty level is outlined in Chapter 5 (see Table 5.7).

these households, their income exceeds their outgoings and they are able to invest in other income generating activities.

However, 35% (n = 34) of the sampled off-road households were classified as relatively poor. These households struggle to meet their subsistence needs and with relatively small landholdings rely heavily on agricultural labouring, portering and house construction. Three percent (n = 3) of the sampled off-road households were classified as destitute: one household is landless and reliant upon day wage labour; the others produce less than one month's food. For these households engagement in waged labour is a strategy for survival.

Fifty-one percent of the sampled off-road households have taken out a loan, the majority of which (n = 43) have debts outstanding. For 21% of households this was to cover general household expenses including food (Table 6.9). Amounts borrowed are generally small with 11 households borrowing less than NRs 5,000 (approximately £40) and 22 households borrowing NRs 10,000 or less (approximately £80). Households with larger loans of NRs 100,000 or more (approximately £830; n = 5) have used the loans to buy land and animals; construct houses; and send family members abroad for employment. More than half of the sampled households (n = 36) sourced their loans from other villagers at high rates of interest.

Table 6.9 Household loans in the off-road settlements of Marmin, Duguna and Listi by reported purpose

	Frequency of households
General expenses (incl. food)	21
To build the family house	8
To aquire land	2
To buy animals	3
Medical expenses	3
To start a business	1
To work abroad	7
Funeral expenses	3
Other	2
Not applicable	48
Total	98

Source: Household Surveys, May 2007

There was certainly some correlation between caste/ethnic group and poverty level (Table 6.10). For example, the three households classified as destitute were all low caste. However, three of the sampled high caste households were classified as relatively poor while 15% (n = 15) of the sampled hill ethnic households were relatively rich. These findings suggest that it is not possible to determine poverty level from caste or ethnicity alone.

Table 6.10 Household poverty level by caste/ethnic group

	Caste/ethnic group		
	High	*Low*	*Hill ethnic*
Very rich	1		1
Relatively rich	3	1	15
Middle income	5	4	31
Relatively poor	3	7	24
Destitute		3	
Total	12	15	71

Source: Household surveys, May 2007

6.3.4 Land ownership

Only 3% (n = 3) of the sampled off-road households were found to be landless (Fig. 6.3). These households include an occupational caste household in Marmin whose 4 ropanis[4] (0.2 ha) of farmland were destroyed by a landslide in 2005; a landless Tamang household in Marmin who constructed a house on government land which was later destroyed by the 2006 Chambang landslide; and a Sherpa woman who lives alone in Duguna and whose farmland has been passed down to her son. However, landholdings are relatively small in the off-road

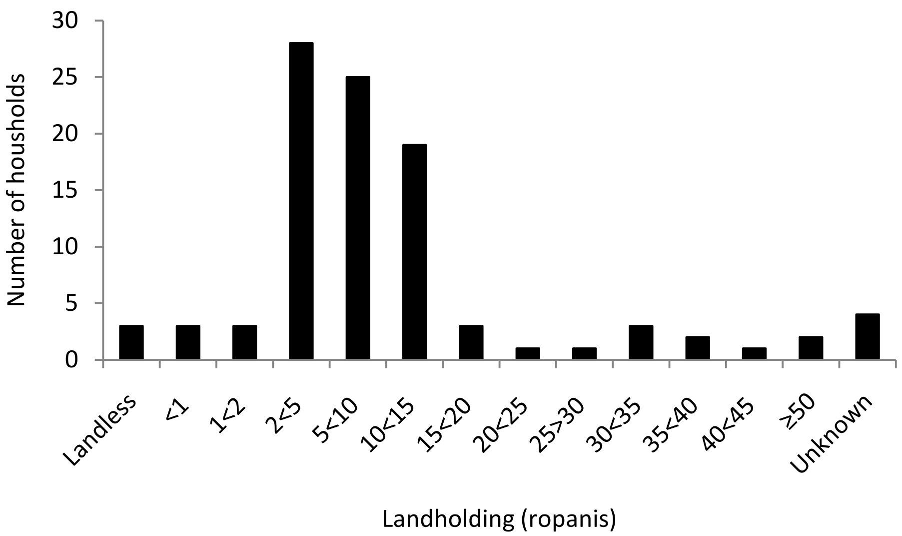


Figure 6.3 Landholdings of the sampled off-road households in Marmin, Duguna and Listi
Source: Household surveys, May 2007

[4] Farmland is measured in ropanis. 1 ropani = 0.05 ha.

settlements with 73% (n = 72) of the sampled households owning between 2 and 15 ropanis (0.1 and 0.75 ha) of farmland. The average landholding for the 94 sampled off-road households was 9.4 ropanis (0.47 ha), 2.8 ropanis less than the average household landholding for Sindhupalchok District of 12.2 ropanis (0.61 ha) (CBS 2006). With the exception of five households who own irrigated (*'khet'*) land, this was all rain-red ('*bari'*).

In the off-road settlements the hill ethnic were found to be the dominant land owners (Fig. 6.4). The larger landholdings of 20 ropanis or more (≥1 ha) belonged to hill tribe households (n = 12) and two high caste Chhetri households, in Marmin and Duguna. None of the occupational caste households sampled owned more than 15 ropanis (0.75 ha) of farmland.

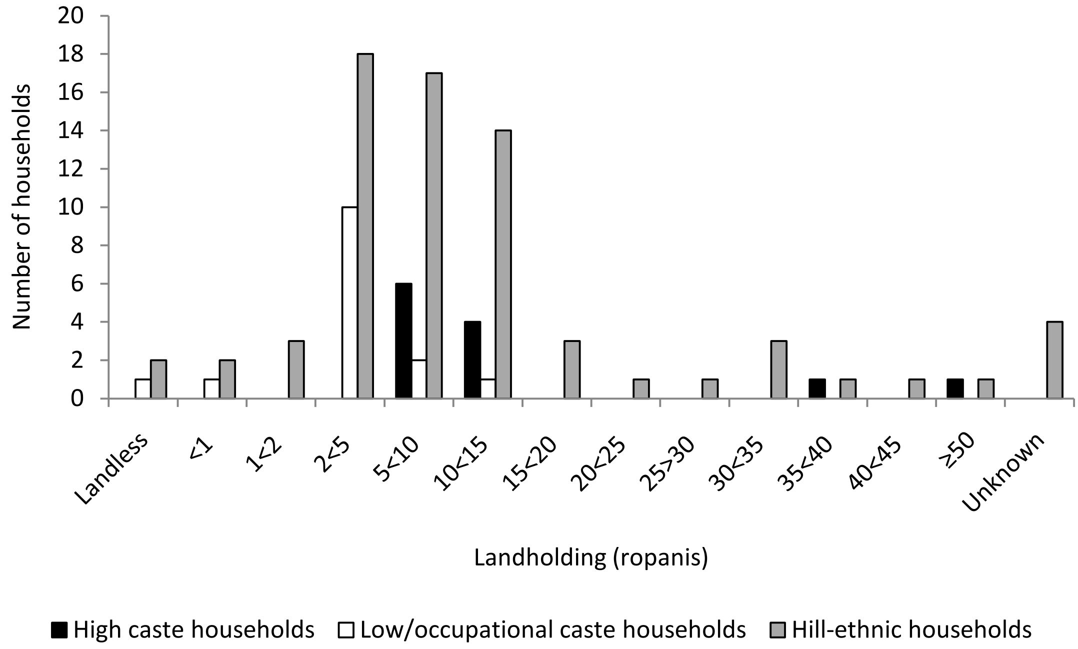


Figure 6.4 Household landholdings by caste/ethnic group in the hill villages of Marmin, Duguna and Listi. Source: Household surveys, May 2007.

In the off-road settlements there is relatively little renting in and out of land. When households do rent land, they use the traditional system of sharecropping or '*adhiya'* (halves), where the crop is evenly divided between the owner and the person cultivating the land. The survey revealed that 13 of the sampled households rent land to others (12 in a sharecropping arrangement) while three of the sampled households sharecrop another farmer's land. These include a relatively poor Tamang family in Marmin; and two middle income Sherpa families in Duguna.

Table 6.11 provides a summary of the mean household landholding by caste/ethnic group in the off-road settlements of Marmin, Duguna and Listi. The mean landholding for high caste households is above the district average of 12.2 ropanis (0.61 ha) (CBS 2006), while the mean landholding for the hill tribe households falls just below. The mean landholding for the occupational caste households falls significantly below the district average.

Table 6.11 Mean household landholding by caste/ethnic group in the off-road settlements of Marmin, Duguna and Listi

	Mean household landholding (ropanis)	Standard deviation
High caste	14.3	1.48
Occupational caste	3.8	5.94
Hill ethnic	9.7	1.77

Source: Household surveys, May 2007.

6.3.5 Subsistence food production

Only 9% (n = 9) of the sampled households meet their subsistence needs and produce food for 12 months of the year; and only one sampled household produces an agricultural surplus (Table 6.12). The main crops grown include maize and millet supplemented with lentils and root crops, principally potatoes.

Table 6.12 Subsistence food production amongst the sampled off-road households

	Frequency of households
Non food producing households	4
<1 month	4
1<3 months	15
3<6 months	34
6<9 months	23
9<12 months	8
12 months	9
Surplus	1
Total	98

Source: Household surveys, May 2007.

6.3.6 The off-road economy

The main economic activity of the off-road settlements is the management of their small farms. Additional employment is often, however, necessary in order to meet the subsistence food deficit. This takes the form of off-farm and on-farm income.

- **Off-farm income** – wage labour on other farms. Payments may be made in cash or food.
- **Non-farm income** – non-agricultural income sources including (i) non-farm wage labour e.g. portering; (ii) formal employment e.g. as a teacher or health post worker; (iii) business income; (iv) remittances from family members working outside the village including local, national, cross-border and overseas migration.

The opportunity for trade in the off-road settlements is severely limited due a lack of access to markets.

The survey showed that three of the sampled 98 households do not have any source of cash income (Fig 6.5). These include a Tamang household in Marmin who produce 12 months food; an elderly Sherpa woman who lives alone in Duguna and who relies on her children for food; and an elderly Sherpa man in Listi who relies on his children for food during the three months he is unable to produce his own.

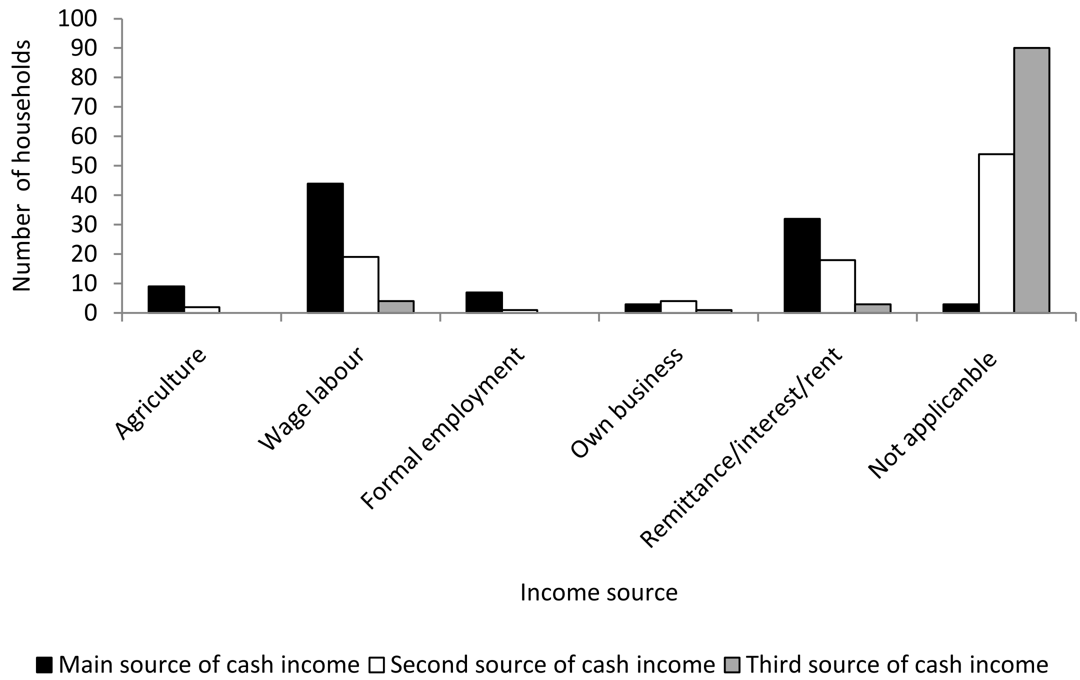


Figure 6.5 Sources of cash income for the sample off-road households in Marmin, Duguna and Listi. Source: Household surveys, May 2007.

For the remaining 95 households, 45% rely on day wage labour including agricultural labouring, house construction and portering. Portering – carrying goods from the road to the hill village or, increasingly, across the Nepal/China border – is an important source of cash income for off-road households with 28 households citing this as their main source of cash income. In addition, 33% (n = 32) rely on remittances from family members working outside the village as their main source of cash income. Less than half (n = 44) of the sampled households have a second source of cash income, with 19 households relying on day wage labour and 18 on remittances. Only eight households had a third source of income.

Only 8 of the sampled households have family members engaged in formal employment including working as teachers and lorry drivers. Similarly, only 8 households own businesses in the off-road settlements including small shops, a small guest house, and small businesses making and selling local alcohol. However, of the 69 split households[5] only 42% (n = 41) receive remittances from family members. The roadside migrants predominantly send food (including rice, salt and oil) rather than remitting funds and, if they do, the amounts tend to be small. In addition, householders engaged in overseas migration often take out sizable loans to cover the cost of relocation and these have to be repaid before household remittance is possible.

6.3.7 The impact of landslide activity

Landslides have had a direct impact on households in the off-road settlements of Marmin, Duguna and Listi, with 64% of the sampled households affected (Table 6.13). Houses have been destroyed in 43% of cases, the majority of which were destroyed by the Marmin landslide approximately 60 years ago (see Chapter 4, Section 4.5.2).

Table 6.13 The impact of landslide hazard in the off-road settlements of Marmin, Duguna and Listi

Impact of landslide hazard	*Frequency*	*Percentage*
Households directly affected by landslide hazard(s)	63	64
House destroyed by landslides	42	43
Family members killed by landslide hazard	3	3
Farmland permanently abandoned	53	54
Farmland temporarily abandoned	5	5

Source: Household surveys, May 2007

In addition, 54% of the sampled households have had farmland destroyed and have been forced to permanently abandon land, while 5% of the sampled households have been forced to abandon farmland temporarily. With the exception of the Marmin landslide, the off-road settlements have been impacted by high frequency, low magnitude events. For the three

[5] The term 'split household' refers to households with family members working outside the village.

households who have lost family members to landslides, these deaths have occurred in landslide disasters at the roadside including a debris flow/flood in Liping in 1995 and the Larcha debris flow in 1996.

6.3.8 Summary

The off-road settlements of Marmin, Duguna and Listi are characterised by small farm households, the majority of which can meet their subsistence needs in normal years but few households manage this from their own account farming alone. Instead, households make up their subsistence food deficit by various non-farm activities, both in situ and ex situ. Outmigration to roadside or urban locales provides access to additional resources and as a result the majority of households are therefore split drawing resources from both off and on-road, and rural and urban sectors. The drivers behind this are complex; for some households outmigration is driven by a pressing need for additional support, whilst for others it is a strategy for consolidation or accumulation. For the very poor, out migration is often not an option and this has significant impact on their access to livelihood opportunities. The landslide hazard off-road is chronic rather than acute, posing greater risk to livelihoods through the destruction of land and property than through direct loss of life.

6.4 On-road settlements

The following section mirrors the section above and outlines the demographic characteristics for the on-road settlements of Chaku, Larcha and Kodari.

6.4.1 Population overview

In contrast to the off-road settlements, the majority of householders on-road are migrants. Of the 67 households surveyed, 49 had recently migrated to the roadside. A more detailed discussion of this migration process is presented in Section 6.5. Reflecting the migrant population, the on-road settlements were found to be more diverse in terms of caste and ethnicity, with a total of eight groups represented (Fig. 6.6). Larcha is dominated by hill tribe households (85%); while Chaku has a relatively even number of high caste and hill tribe households (46% hill tribe and 44% high caste). Kodari, the settlement closest to the Nepal-China border, is the most ethnically diverse of the on-road settlements with 36% of the population classified as high caste, 24% low caste and 15% hill ethnic. Table 6.14 provides an overview of the sampled on-road households by caste/ethnic group.

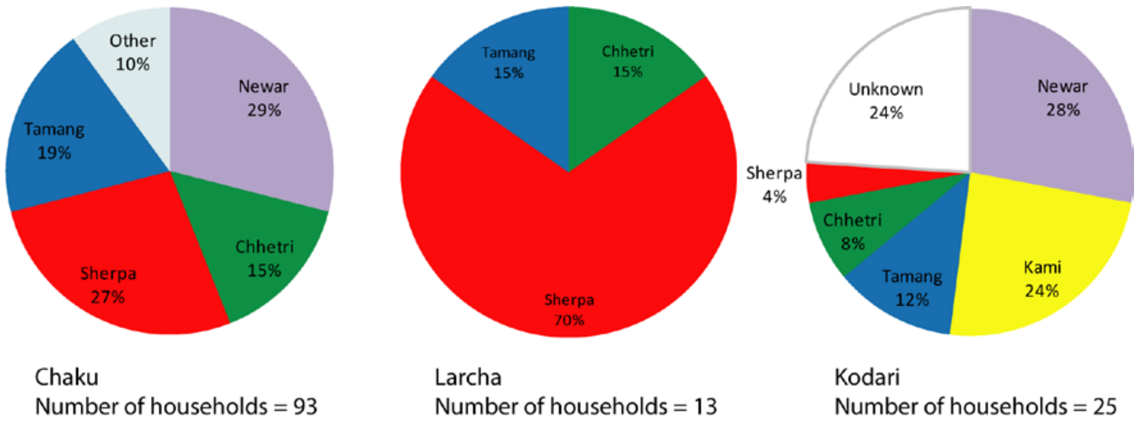


Figure 6.6 Population distribution by caste/ethnic group in the on-road settlements of Chaku, Larcha and Kodari. Source: Baseline surveys, October 2006.

Table 6.14 Caste/ethnic breakdown of the sampled on-road households in Chaku, Larcha and Kodari

Caste/ethnic group	*Sub-group*	*Frequency of households*
High caste	Brahmin	1
	Chhetri	10
	Newar	11
Low/occupational caste	Kami	10
Hill tribe	Gurung	1
	Rai	1
	Sherpa	21
	Tamang	12
Total		67

Source: Household surveys, October 2006

Reflecting the high rate of outmigration of the younger generation from the hill-villages to the roadside, the distribution of the on-road population by age and sex shows the relative youth of the inhabitants (Fig. 6.7). The household survey shows that 69% of people (n = 203) are aged thirty four or below, while more than half of the sampled population (n = 161) is younger than 25. The higher number of females in the 15-24 age group suggests that while traditionally, it was the male members of the household who engaged in migration (see, for example, Seddon *et al.* 2002), young women are now migrating too. With the exception of the 15-24 age group, there seems to be no significant difference between the number of males and females and their relative distribution.

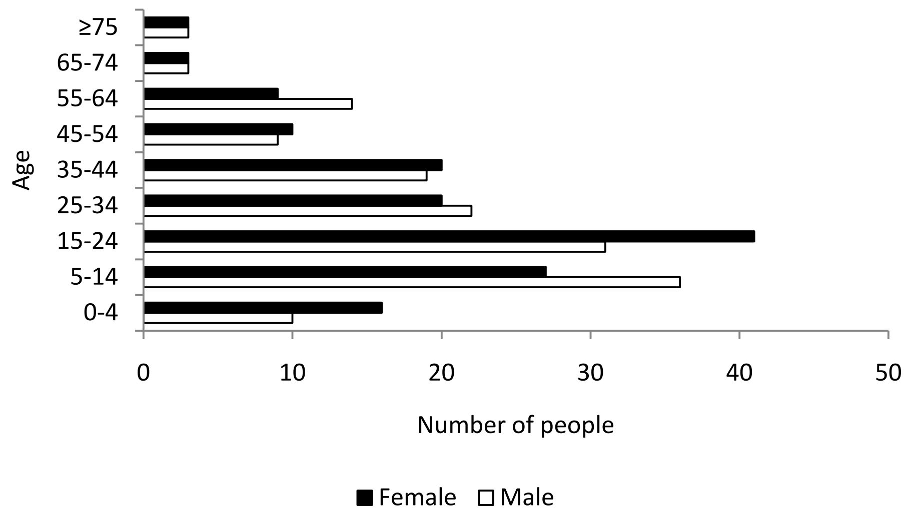


Figure 6.7 The sampled on-road population by age and sex. Source: Household surveys, October 2006

The mean household size in the on-road settlements is five, which includes all household members even those residing outside the village (Table 6.15). The mean household size, based on the number of people who reside in the village and share the kitchen is four (Table 6.15).

Table 6.15 Frequency distribution of household size

Household membership	*Frequency of households*	*Family members sharing the kitchen*	*Frequency of households*
1	0	1	3
2-3	21	2-3	26
4-5	14	4-5	20
6-7	20	6-7	10
8-9	9	8-9	7
10-11	3	10-11	1
Total	67	Total	67

Source: Household surveys, October 2006

Of the 67 households sampled, 10 are permanently headed by women, the majority of which are widows living with their married sons and grandchildren. In addition, two households are de facto female-headed as their husbands are working and residing outside the village, returning for one or two days per month.

6.4.2 Poverty level

Within the household survey, 46% (n = 31) of the sampled roadside households were classified[6] as middle income and 34% (n = 23) as relatively rich (Table 6.16). Focussing on the 49 migrant households specifically, 53% (n = 26) were classified as middle income and 31% (n = 15) as relatively rich. On-road, far fewer households were classified as very poor or destitute (13%, n = 9 and 0%, n = 0 respectively) than in the hill villages (35%, n = 34) and (2%, n = 3). Taking an aggregate view, these data suggest that roadside migration was born out of choice rather than necessity or survival. While at this stage it is useful to dichotomise households in this way to broadly characterise the underlying trends and processes, it is important to recognise that individuals and households are influenced by a multiplicity of factors. These will be explored in Section 6.6.

Table 6.16 Poverty classification of the on-road households of Chaku, Larcha and Kodari

	Household poverty level			
	Very rich	*Relatively rich*	*Middle income*	*Relatively poor*
Non-migrant households	2	8	5	3
Migrant households	2	15	26	6
Total	4	23	31	9

Source: Household surveys, October 2006

It is important to note that it is not possible to read-off and determine the household poverty level based on caste/ethnicity alone. As Table 6.17 demonstrates, the sample included four relatively poor high caste households; four relatively rich and one very rich low caste household.

Table 6.17 Poverty classification of the on-road households of Chaku, Larcha and Kodari by caste/ethnic group

	Caste/ethnic group		
	High caste	*Low caste*	*Hill ethnic*
Very rich	2	1	1
Relatively rich	7	4	12
Middle income	9	4	18
Relatively poor	4	1	4
Total	22	10	35

Source: Household surveys, October 2006

[6] The methodology used to determine household poverty level is outlined in Chapter 5 (Table 5.6).

Half of the sampled on-road households (n = 34) have taken out a loan. Unlike the off-road households, these loans are used for business rather than buying food to meet subsistence needs. The amount borrowed is therefore greater with 18 households borrowing NRs 25,000 or more (approximately £210) and 11 households borrowing upwards of NRs 50,000 (approximately £420). While the majority of loans were taken from other villagers, a number of households accessed loans from banks and cooperatives suggesting better access to capital at the roadside. The ability of on-road households to repay the loan is also greater, with more than half of the sampled households having repaid their debt.

Table 6.18 Household loans in the on-road settlements by reported purpose

	Frequency of households
To build a house	6
To buy animals	1
To buy stock for the roadside business	3
Medical expenses	2
To start a business	3
To expand a business	3
To work abroad	2
Funeral expenses	4
General expenses	4
Other	6
Total	34

Source: Household surveys, October 2006

6.4.3 Land ownership

While 45% (n = 30) of the sample households own their house plot, 19% (n = 13) have built houses on government land. Of the 13 households, five of the households were resettled by the government following the 1981 Kodari landslide. The remaining eight households have illegally encroached on government land at the roadside. These houses are located in Chaku (to the north of Chaku bridge) and at "4 km Settlement". It is of interest to note that it is illegal to settle on the land within 25 m either side of the centre of a strategic road such as the Arniko Highway. Based on this, all three case study settlements are illegally located. However, as explained by a resettlement specialist working for the Government of Nepal's Decentralised Rural Infrastructure Project (DRILP), this policy was put in place after the construction of the Arniko Highway in 1967 (Subedi *pers comm.*). As a result, households were not compensated for their loss of land or resettled. The roadside settlements along the highway have therefore expanded with no repercussion from the government.

Thirty six percent of the sample roadside households are landless at the roadside while 28% own their house plot only (Fig. 6.8). For the remaining 36% of sampled households, roadside landholdings are small, with 19% owning less than 10 ropanis (0.5 ha) of farmland. However, 57% (n = 38) of the sampled on-road households own land off-road, often in the hill villages from which they have migrated. Landholdings are larger off-road with 30% (n = 20) of the sampled households owning more than 10 ropanis of farmland. Only 12% (n = 8) of the sampled households own more than 25 ropanis (1.25 ha) off-road. These include five high caste households and three hill tribe households. Of the 57% (n = 38) of households with landholdings off-road, 12% (n = 8) tend their land. For 28% (n = 19) of the households, the land is tended by other family members, while 12% (n = 8) have their land sharecropped by others and receive half of the crops harvested.

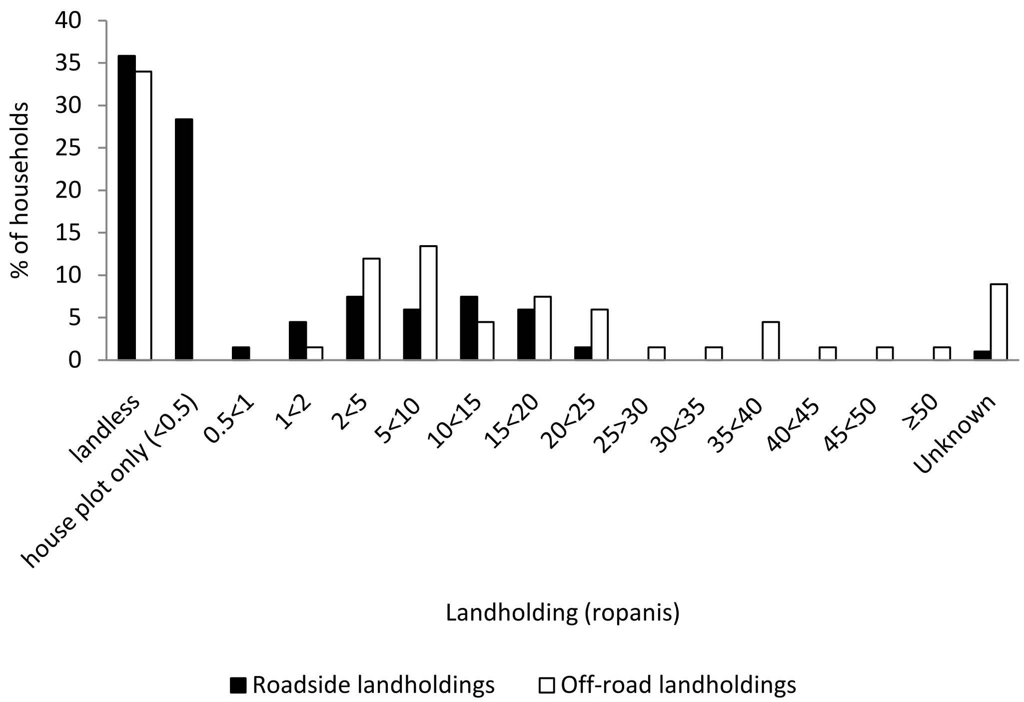


Figure 6.8 Size distribution of land holdings at the roadside based on 67 household observations. Source: Household survey, 2006.

As the survey shows, 36% (n = 8) of the sampled high caste households, 50% (n = 5) of the sampled low/occupational caste households and 31% (n = 11) of the sampled hill tribe households are landless at the roadside. While 32% (n = 7), 60% (n = 6), 29% (n = 10) respectively are landless off-road. When taking into account landholdings both on and off-road, only 3 of the sampled 67 households are completely landless. These households include a low caste Kami household in Chaku who migrated to the roadside five years ago from Gathi VDC; a Sherpa family in Chaku who sold their yak farm in Narayanthan and built a house on government land at the roadside; and a middle aged Sherpa woman living alone in Larcha whose husband married another woman.

It is interesting to note that the larger landholdings of more than 10 ropanis (0.5 ha) at the roadside belong to high caste Chhetri and Newar households (6% of the sampled roadside households; n = 4), low caste Kami households (4% of the sampled roadside households; n = 3) and hill tribe Sherpa and Tamang households (4% of the sampled roadside households; n = 3) (Fig. 6.9a). The larger off-road landholdings of >25 ropanis (>1.25 ha) belong to Sherpa and Tamang (hill tribe) households (7% of the sampled roadside households; n = 5) and high caste Chhetri and Newar households (4% of sampled roadside households; n = 4) (Fig. 6.9b). These findings, at least in part, challenge current understanding regarding inequitable landownership between the high caste, low caste and hill ethnic groups.

However, while the occupational caste households have some of the larger landholdings at the roadside, they are seen to have significantly smaller landholdings off-road than the sampled high caste and hill ethnic households (Fig. 6.9b). None of the 10 occupational caste households surveyed owned more than 10 ropanis (0.5 ha) of land off-road. This reflects the traditional caste relationship between the agricultural producers (the high caste Chhetri and the hill tribe Sherpa and Tamang households) and members of the traditional occupational groups. Traditionally landless, occupational caste households often remain dependent on their high caste or hill tribe patrons for land and/or grain, in exchange for their services (Blaikie *et al.* 2001).

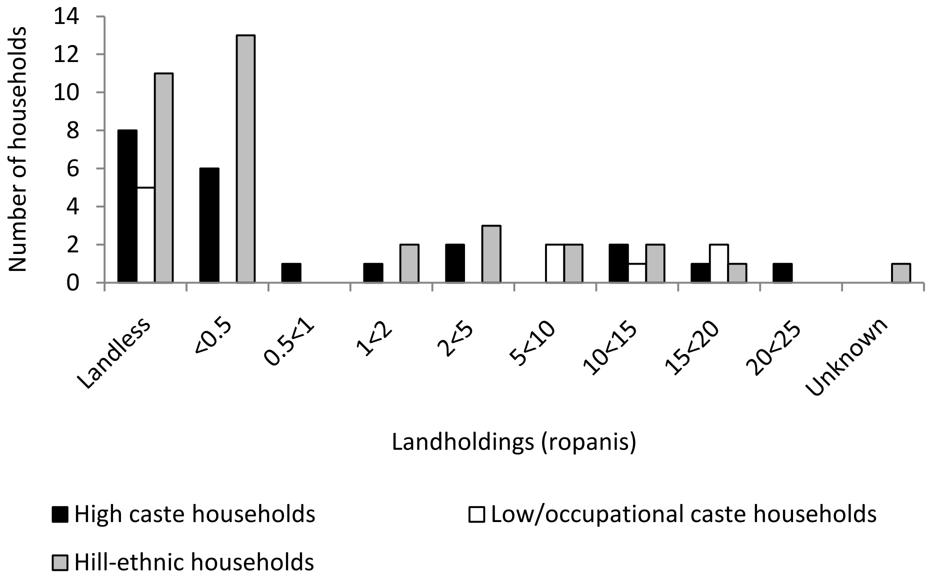


Figure 6.9a Roadside landholdings by caste/ethnic group

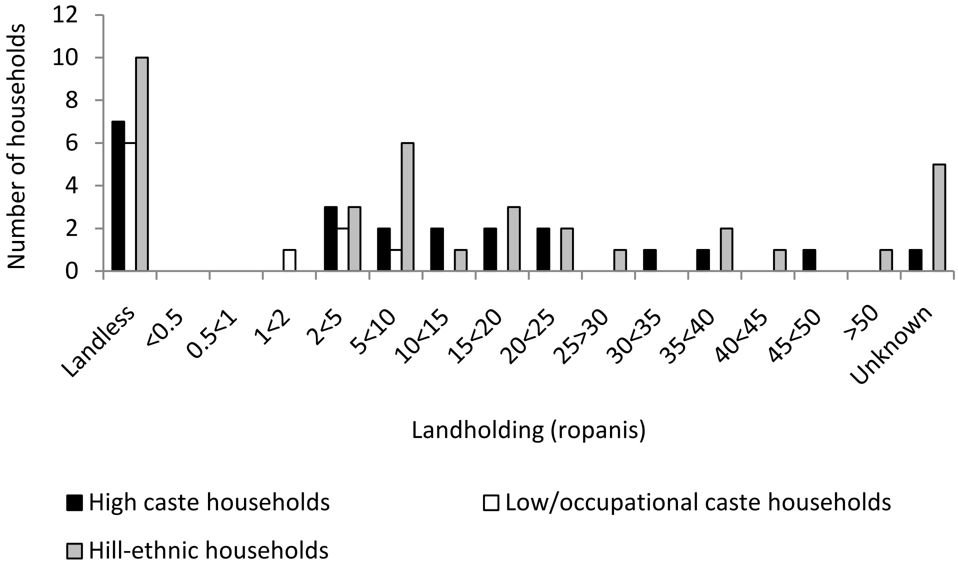


Figure 6.9b Off-road landholdings by caste/ethnic group. Source: household surveys, October 2006

6.4.4 Subsistence food production

For the majority of roadside households, agriculture does not provide a source of cash income. This may, at least in part, be attributed to the subsistence food deficit which characterises the majority of sampled on-road households (Table 6.19) and the operation of the wider market economy which has provoked livelihood diversification. The survey shows that 30% (n = 20) of the sampled roadside households do not produce any of their own food; 59% (n = 40) produce food for less than three months of the year; and only one sampled roadside household generates an agricultural surplus.

Table 6.19 Subsistence food production amongst the sample roadside households

	Frequency of households	*Percentage of households*
Non food producing households	20	30
Kitchen garden only	3	4
<1 month	11	16
1<3 months	6	9
3<6 months	8	12
6<9 months	14	21
9<12 months	0	0
12 months	4	6
Unknown	1	1
Total	67	100

Source: Household surveys, October 2006

While 66% (n = 44) of sampled households own livestock they are generally reared for home consumption (e.g. for the agricultural products including milk, ghee and eggs and the meat during festival time) or as working animals. Overall, these findings question the centrality of agriculture in the livelihoods of the roadside population affirming the findings of Seddon *et al.* (2002) who note that '*the rural population of Nepal consists not of 'farmers' but of individuals and households whose livelihoods are sustained by a wide variety of activities and income sources, many of them not only 'off' their own plots but outside agriculture altogether'* (p. 20).

6.4.5 The on-road economy

Of the sampled roadside households, 30% (n = 20) rely on a single source of cash income (Figure. 6.10). Household businesses (e.g. small hotels and shops) play a central role in the roadside economy. For 40% (n = 27) of the sampled households their business activities provide the main source of household income. Day wage labour is important for 30% (n = 20) of households (12% carry goods across the Nepal-China border; 10% work in the stone quarry; 3% load lorries at the border; and 5% are engaged in other day wage activities including masonry work and agricultural labour). Formal employment is the main source of cash income for 16% (n = 11) of households; employers include the Customs Office, the Chaku hydropower plant, the Veterinary Office, and the state (teachers and local government officials).

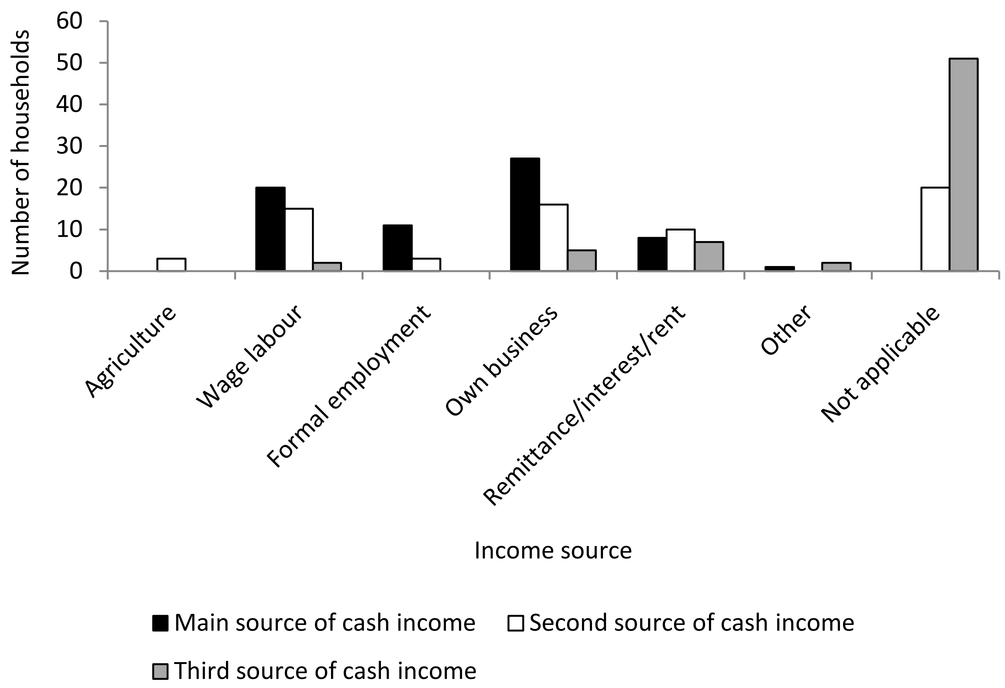


Figure 6.10 Sources of cash income for the sample roadside households (n = 67 households)
Source: Household surveys, October 2006

For the 70% (n = 47) of sampled households who have a second source of cash income, this usually takes the form of day wage labouring or income generated from a roadside business. Only 24% (n = 16) of sampled households have a third source of cash income. These income sources include remittance; interest from loans or rent from a second or, in come cases, a third property; wage labour; or income from a roadside business.

Thirty per cent (n = 20) of the sampled roadside households have one or more family member(s) working outside the Upper Bhote Koshi Valley. A total of 29 people from the sampled households reside outside the Valley. 24% (n = 16) of households have one or more family member(s) engaged in short-term (i.e. weekly or monthly) migration. The majority (15%) are employed as lorry drivers or assistant lorry drivers while the remainder have jobs in Kathmandu. Twelve percent (n = 8) of the sampled roadside households have one or more family member(s) engaged in longer-term migration (i.e. for more than six months) outside Nepal: three in Asia (including China and India) and five overseas in Oman, Qatar, South Korea and Malaysia.

Remittances are believed to constitute an important and underestimated component of household income in rural Nepal (Seddon *et al.* 2002). This is certainly the case in off-road settlements where the remittance economy is important for 32% of households (see Section 6.3.6). However, it is much less important on-road where only 18% of the sampled households (n = 12) receive remittances from household members working away from home. It may be that the funds are brought back in the form of gifts or at the end of a period of working abroad; or that the majority of roadside households are economic migrants themselves remitting funds to family members in their village (i.e. the off-road settlement they migrated from). A more detailed analysis of the survey data reveals that 66% off roadside households can be classified as 'split households' – in this context households 'straddling' the on-road and off-road sectors. Roadside migrants in the Upper Bhote Koshi Valley maintain strong off-road family connections.

Circular migration, in which family members work for periods in the urban economy (usually in India or the Middle East) before returning to their family farms (Ellis 1998) has been noted in the Upper Bhote Koshi Valley. Examples include a relatively rich Sherpa household originally from Bhakang, Listikot VDC, who migrated to India for employment in the construction industry in the early 1990s. Upon their return to Nepal, the household returned to the Upper Bhote Koshi Valley, bought land and built a house in Chaku. Similarly, a relatively rich Tamang family in Larcha originally from Duguna, Tatopani VDC, bought a small plot of land at the roadside and built a house 20 years ago (1986) before migrating to India for construction work. They returned to Nepal in 1996 and settled in Larcha.

6.4.6 The impact of landslide activity

Like the off-road settlements, landslides have had a direct impact on the on-road settlements of Chaku, Larcha and Kodari (see Chapter 4, Section 4.5.1). Findings from the household surveys show that 45% of the sampled households have been directly affected by landslides either through the death of a family member, injuries or property damage (Table 6.20).

Table 6.20 The impact of landslide hazard in the on-road settlements

Impact of landslide hazard	*Frequency*	*Percentage*
Households directly affected by landslide hazard(s)	30	45
House destroyed by landslides	17	25
Family members killed by landslide hazard	1	1
Farmland permanently abandoned (on-road)	9	13
Farmland temporarily abandoned (on-road)	12	18
Farmland permanently abandoned (off-road)	5	7
Farmland temporarily abandoned (off-road)	0	0

Source: Household surveys, October 2006

While only one of the roadside households has lost family members in a landslide, it is important to remember that the settlement of Larcha was completely destroyed by a debris flow in 1996 which killed 54 people. This highlights the catastrophic nature of landslides in the valley bottom. The survey shows that 25% of the sampled households have had their houses destroyed by landslides, while 31% have been forced to abandon their land permanently at the roadside, and 18% temporarily, with the intention of moving back when the land stabilises. Seven percent of the sampled on-road households have also abandoned land off-road due to slope failure.

6.4.7 Summary

The landslide prone settlements of Chaku, Larcha and Kodari are largely populated by migrant households. As a result, in contrast to the hill settlements, there is greater ethnic and caste diversity and a younger population. There are fewer relatively poor and destitute households and business, rather than subsistence agriculture, is the primary support to livelihoods. For the roadside households, landslide hazards, such as the Larcha debris flow, pose an acute rather than a chronic threat.

6.5 Migration patterns in the Upper Bhote Koshi Valley

Having provided the social context for the on and off-road settlements, this section focuses on the impact of the construction of the Arniko Highway in 1967 which had a profound influence on settlement patterns in the Upper Bhote Koshi Valley. Of the 67 roadside households surveyed, 73% (n = 49) are migrant households. While there is some evidence of inter-district and inter-regional migration (6% of the migrant households are from the neighbouring districts of Dolakha and Kavrepalanchok, 4% from Eastern Nepal and 2% from the Indian state of West Bengal), 88% (n = 43) of the migrant households are from Sindhupalchok District and VDCs within the Bhote Koshi Valley (Table 6.21).

Table 6.21 The origin of migrant households in the Upper Bhote Koshi Valley

Country	*Region*	*District*	*% of migrant households*
Nepal	Central Region	Sindhupalchok	88
		Dolakha	4
		Kavrepalanchok	2
	Eastern Region	Janakpur	2
		Khotang	2
India	West Bengal	-	2
		Total	**100**

Source: Household surveys, October 2006

Focusing on the migration patterns within Sindhupalchok specifically, roadside households have migrated from 25 different villages across 10 different VDCs (Table 6.22 and Figure 6.11). 62% (n = 16) of the migrant households in Chaku and 83% (n = 5) in Larcha have migrated to the roadside from hill villages within the same VDC. By comparison, only 7% (n = 1) of the migrant households in Kodari are from Tatopani VDC. However, while households seem willing to migrate further to live in a border town, the migration pattern is still narrowly confined to hill villages in the Bhote Koshi Valley with three notable exceptions: two households from neighbouring Dolakha District and one from West Bengal. In all three cases, the households have migrated to Kodari to take advantage of the business opportunities associated with the Nepal-China border. As one informant explained:

> *"Kodari is a good place to run a business because it's near the border with China."*
> (Male respondent, Tamang, 28 years, educated to secondary level)

The household survey showed that 94% (n = 46) of the migrant households sampled relocated to the valley bottom after the Arniko Highway was constructed, a finding congruent with the observations of village elders. The emergence of linear roadside settlements has been noted elsewhere in Sindhupalchok District and Nepal. For example, following the completion of the Lamosangu-Jiri Road in Sindhupalchok and Dolakha Districts[7] in 1977, the number of houses located within the 200 m road corridor increased by 15-20% per year between 1977 and 1994 (an increase from several hundred to 2,500 houses between 1977 and 1994) (INFRAS 1995).

Table 6.22 Roadside migration patterns within the Bhote Koshi Valley

Settlement	*Location*	*VDC*	*Village*	*No. households*
Chaku	Upper Bhote Koshi Valley	Gati	Gati	1
			Tyanthali	2
		Ghumthan	Nakuche	1
		Marmin	Anthali	1
			Chhadi	1
			Lampate	1
			Marmin	1
			Marmin Branka	1
		Phulpinkatti	Khukundol	1
			Narayanthan	5
			Parsela	1
			Phulpin	1
			Yarmala	3
	Lower Bhote Koshi Valley	Ghorthali	Dolansa	1
		Makha	Lamosagu	1
		Unknown	Those Khani	1
4km Settlement	Upper Bhote Koshi Valley	Tatopani	Larcha	1
Larcha	Upper Bhote Koshi Valley	Listikot	Listi	1
		Tatopani	Duguna	5
Kodari	Upper Bhote Koshi Valley	Ghumthan	Unknown	2
		Listikot	Listi	2
			Panlan	3
		Phulpinkatti	Narayanthan	1
		Tatopani	Nadung	1
	Lower Bhote Koshi Valley	Barabise	Hakang	1
			Unknown	1
		Dhuskun	Dadagau	1
			Total	43 (88%)

Source: Household surveys, October 2006

[7] This rural road links the town of Jiri with the Arniko Highway near Lamosangu.

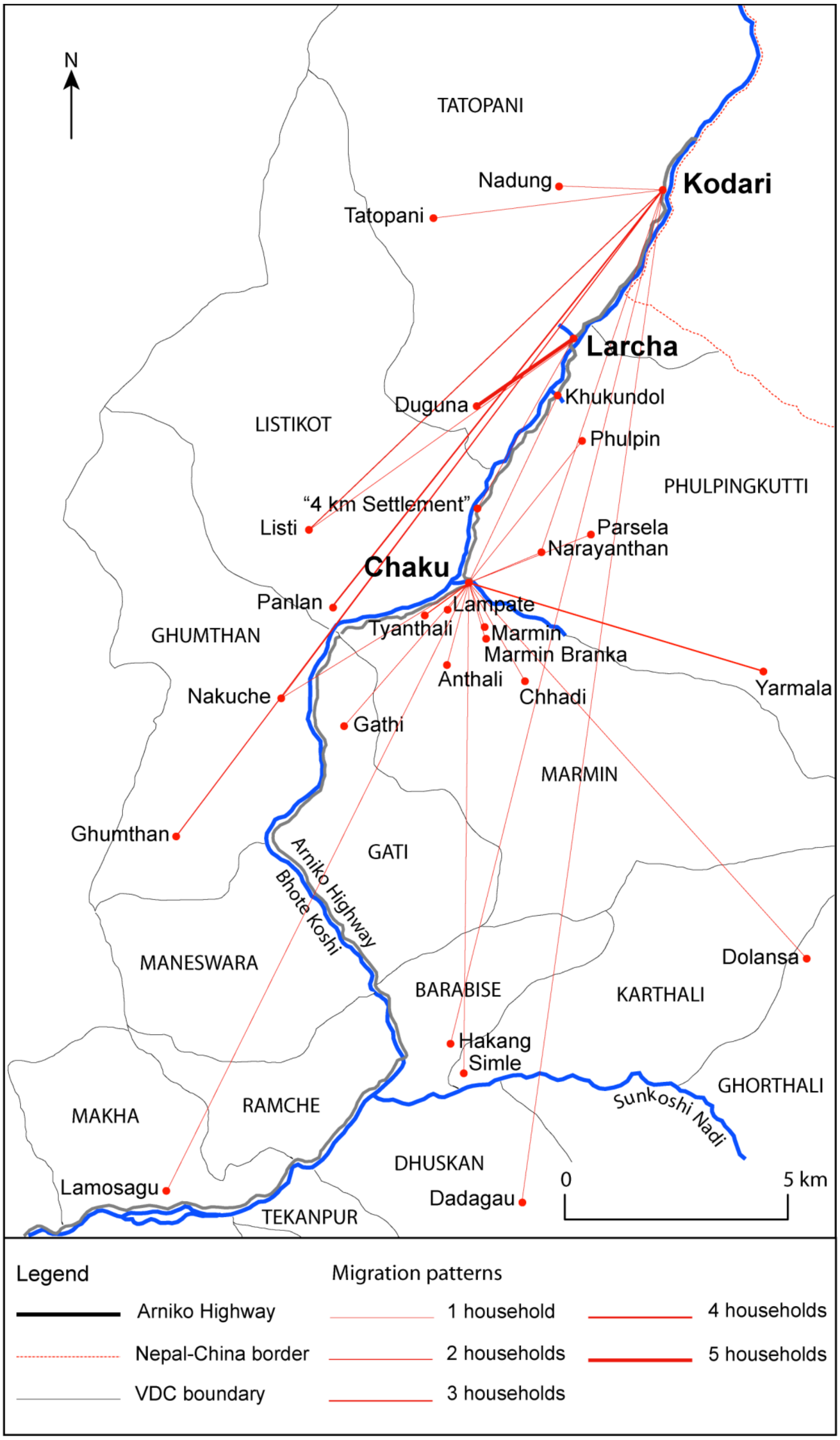


Figure 6.11 Migration patterns in the Upper Bhote Koshi Valley. Source: Household surveys, October 2007.

Outmigration from the hill villages to the roadside did not occur immediately following the construction of the highway. Instead, based on the sample population, the road had been constructed for more than 10 years before there was any sign of roadside migration. This appears to be a more recent trend with 82% (n = 40) of the sample households migrating to the roadside from the early 1990s onwards (Fig. 6.12).

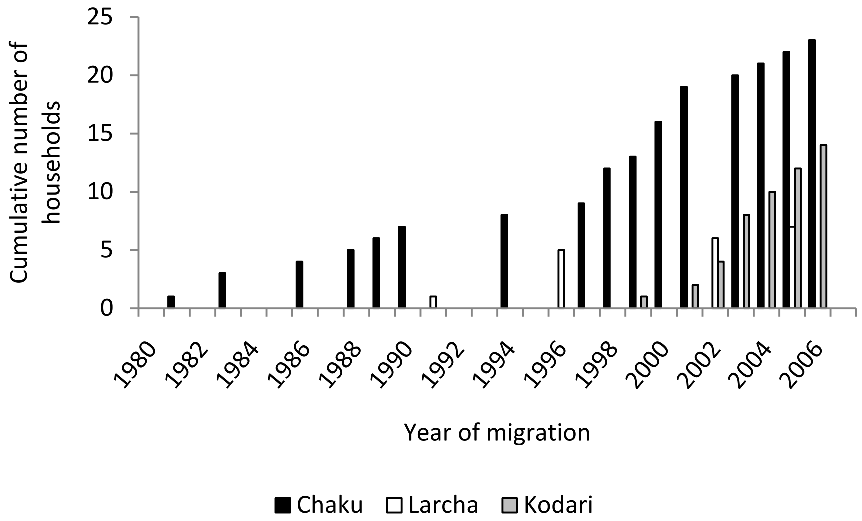


Figure 6.12 Roadside migration patterns in the Upper Bhote Koshi Valley. Source: Household surveys, October 2006

There are three possible explanations for the observed lag in roadside migration:

1. *Limited opportunities for involvement in the market economy*

   Leinbach (1995) argues that the construction of roads alone has a limited impact on development in rural areas. The Upper Bhote Koshi Valley is characterised by a subsistence economy and while a road may provide cheap transport to and from agricultural markets, a change in the mode of agricultural production is required for there to be economic benefit. With limited potential for the commercialization of agriculture in the hills, reflecting low agricultural productivity, households in the Upper Bhote Koshi Valley continue to have limited involvement in the market economy. For the off-road households which generate an agricultural surplus, for example Listi village which cultivates potatoes, the opportunity to engage in the market economy is constrained by accessibility problems and the high costs of market transport. Similar findings have been noted elsewhere in Sindhupalchok in the vicinity of the Lamosangu-Jiri Road (INFRAS 1995) and in neighbouring Rasuwa District along the Kathmandu-Somdang Road (Campbell 1993).

2. *The highway was constructed for military and strategic purposes rather than trade*
   The Arniko Highway was constructed by the Chinese government for military and strategic purposes in the 1960s (Shaha 1973). The road opened in 1967 but the severe trade restrictions imposed by China and India meant the highway had no economic or commercial value. Concerned principally with its political control over Tibet, China ended all private, Lhasa-based Nepalese trade by 1966 and by 1968 had ended traditional transhumance and cross border barter trade (Whelpton 2005). Until the re-opening of the Nepal-China border for trade in the early 1990s, there was no real economic incentive for roadside migration. Since then, the economic opportunities associated with cross-border trade have increased.
3. *Lag in the provision of services*
   Roads are associated with the service provision including schools, health care facilities and a greater variety of consumer goods (Jacoby 2000) but these amenities do not arrive straight away but 'colonise' the space that road construction opens up over a period of several years.

I was interested to explore the reasons behind this outmigration from the hills and the expansion of roadside settlements which has resulted in a concentration of people in landslide prone areas. Does the short distance migration observed reflect a crisis in the hills or the draw of the road, or a combination of both? These factors will now be explored.

6.6 Factors driving the occupation of landslide prone areas: 'push' versus 'pull'

The reason that households occupy landslide prone areas can be divided into two overarching considerations, necessity and choice. Elsewhere in the literature this has been expressed as a contrast between survival and choice or between survival and accumulation. In the migration literature, this corresponds to push versus pull reasons for migration. As noted by Ellis (2000), necessity refers to involuntary and distress reasons for migration. Examples include the eviction of tenant families from their access to land, environmental deterioration leading to declining crop yields, natural or civil disasters such as drought, flood or civil war resulting in the dislocation and abandonment of assets. Choice, by contrast refers to voluntary or proactive reasons for diversifying. For example, travelling to find employment; educating children to improve their job prospects; or saving money to invest in non-farm businesses such as trading. On the one hand, the very poorest rural households are not able to migrate as they are tied to their assets in the village. On the other, the very poorest households are likely to have few, if any, fixed assets and are therefore likely to be the most mobile.

The 'necessity' concept in this context is based on the well cited and logical argument that increasing population pressure, unequal access to land, lack of employment opportunities and poverty force people to settle in high-risk areas (Burton *et al.* 1993; Wisner *et al.* 2004). A household occupying a high risk area may be unable to move because their fixed assets and poverty level ties them to a particular location. Alternatively, the occupation of hazard prone areas may take the form of poverty-induced forced migration into a high–risk zone (Lein 2000). Both claims are based on the assumption that migration is forced or involuntary, whereby people do not choose to either move or stay (ibid). Table 6.23 summarises the 'push' and 'pull' factors giving rise to roadside migration and the subsequent occupation of landslide prone areas in the Upper Bhote Koshi Valley. These factors are discussed in detail in Sections 6.6.1 and 6.6.2.

Table 6.23 Migration and mobility in the Upper Bhote Koshi Valley: causal factors

Category	*'Push' factor*	*'Pull' factor*
Resources & environment	Low productivity of farmland Unreliable water supply Women forced to walk further to collect firewood and fodder Loss of land due to erosion and landslides	Reliable water supply
Economic	Low agricultural productivity Few, if any, employment opportunities beyond agriculture	Opportunity to establish small scale businesses e.g. tea houses; small hotels and shops; trade and transport businesses Expansion of employment opportunities in India and the Middle East – attraction of remittance economy to rural households The potential accumulation of a degree of wealth Road access
Social	Village life is difficult Limited opportunities Desire for betterment	Growing wants driven by consumerism/modernisation Education for children
Political	Decade-long civil conflict has driven households from Maoist controlled rural areas into government controlled population centres	

Source: Household surveys, October 2006 and May 2007

6.6.1 'Push' factors

Only 9% of sampled off-road households produce food for 12 months of the year and only one of the sampled households produces a surplus. Off-road households therefore engage in off-farm and non-farm employment to make up the subsistence food deficit. However, employment opportunities are limited beyond agriculture and wage labour is irregular. For those households with a surplus crop there are few opportunities to sell their produce. As a resident of Listi explained:

> *"The younger generation they want jobs. They want better opportunities than they have here in Listi. All the young people are leaving the village. We need a road so the young people will stay. We can sell our potatoes that way and there will be opportunities for us."*
> (Male respondent, Newar, 60 years, educated to primary level)

Furthermore, there are limited opportunities beyond subsistence agriculture in the off-road settlements. Respondents described village life as 'difficult' and they want more from life than a subsistence existence. Of the 49 migrant households sampled at the roadside, 44% have relocated in search of better opportunities.

> *"Very few people go beyond lower secondary school – young people have to work for their livelihood"*
> (Female respondent, Sherpa, 23 years, non-literate)

In addition, the environment itself represents a push factor. The relatively small landholdings are comprised of poor quality, steep, rain-fed land. This land is frequently abandoned due to landslide activity and gully erosion which further reduces the already small landholdings. With the community forests zoned to protect the forest resource, women have to walk further to collect fodder and firewood. In addition, the water supply is unreliable and unsuitable for drinking.

Political pressures: The Maoist insurgency

It is notable that roadside migration coincides with the initiation of the civil conflict. The Maoists have been in *de facto* control of Sindhupalchok District since the declaration of a 'People's Government' in 2001 (Sharma 2003). With government forces strategically located along this main arterial road, it was possible that people were migrating from Maoist controlled hill villages to the government controlled roadside settlements. With internal migration being reported in conflict situations elsewhere (Wisner *et al.* 2004) this seemed a plausible outcome. While my informants did not cite the insurgency as a reason for their migration, this was something they were unlikely to divulge or discuss through fear of reprisal from Maoist or government forces (see, for example, Pettigrew 2004).

Informal discussions with householders revealed that those of Tamang and Sherpa ethnicity were supporters of the Communist Party of Nepal (Maoist)[8], the Communist Party of Nepal (Unified Marxist-Leninist) party[9], the Nepali Congress Party[10], and the Rastriya Prajatantra Party[11]. While villagers in Listi and Duguna were less involved in the Maoist movement, the ethnic tribal groups in the Upper Bhote Koshi Valley were, in general, strong supporters of the Maoist rebellion. My findings were therefore congruous with those of Shneiderman and Turin (2004) who have undertaken a rare ethnography exploring the village perspective of the Maoist Movement in neighbouring Dolokha District. They argue *'that the practical ideology advanced by the Maoists at the village level compelled people to join what they perceived to be a social movement which promised concrete improvements in their own living conditions'* (Schneiderman and Turin 2004: 103). Ultimately, it is difficult to separate the Maoist Insurgency from other push factors. It may be that the insurgency has played a more tacit role and affected some of the economic factors driving people to leave the hill villages. On the other hand, it may simply be that the insurgency is an additional factor in the background with no direct influence on settlement patterns. Without further information it should be recognised as a potential factor contributing to the overall social context.

6.6.2 'Pull' factors

The economic advantages associated with a roadside location were the most significant pull factors. The opportunity to establish small businesses, expand employment opportunities and the potential for the accumulation of a degree of relative wealth were key amongst these. Second to these were social factors including access to education, and the desire to live a modern life. In addition, access to a reliable water supply was seen as an advantage of the roadside settlements. The key household needs that drive the main pull factors above are discussed in more detail in Chapter 7.

6.7 Case studies

The 'push-pull' debate above is useful as a means of identifying overall trends in migration patterns. However, it can be seen to impose a false duality on what is, in reality, an interlocking set of processes. The following section focuses on four case studies in an attempt to unpick the complexity surrounding the variety of factors involved in the decision-making process behind household migration. In doing so, I discuss a further binary of choice versus

[8] The CPN(M) is the major ruling party in Nepal leading a coalition government with the CPN(UML).
[9] The CPN(UML) is the second largest communist party in Nepal.
[10] The main opposition party.
[11] The Rastriya Prajatantra Party is a right-wing, royalist political party in Nepal.

limited or constrained choice. Whilst I see choice as part of a spectrum rather than black and white categories, the binary presented below provides a useful lens through which to consider household agency in terms of control over migration trends.

6.7.1 Limited or constrained choice

Case study: A relatively poor low caste household in Chaku

A family of six live in the basement of a four storey 'pakka[12]' house located next to the main road in the landslide prone area of Chaku (Fig. 6.13). The three houses next door were destroyed by the 2001 Chaku landslide. The family occupy a small, single room in the large brick house, the owner of which lives in the nearby town of Barabise. Lalmata (36 years) moved to Chaku with her husband, father in-law and three children in 2002 from the nearby hill village of Gathi. They had no land of their own in Gathi and sharecropped land but village life was hard. The sheer inadequacy of income from sharecropping and farm labouring propelled the household to the roadside in search of day wage labour. Their decision to migrate can therefore be viewed as a strategy of sheer survival. Lalmata's husband works in the nearby stone quarry where he earns NRs 100 per day while she undertakes piecemeal work as an agricultural labourer during the months of April, July and December. Sometimes Lalmata collects firewood to sell. Being landless, they have to buy all their food and cover the rent of NRs 200 per month. They used to have a goat but they sold it to pay back a loan. They took out a second loan of NRs 20,000 in 2004 for general household expenses and still owe NRs 10,000. Their two children of school age attend Chaku Public School. Lalmata is more than aware they live in a landslide prone area and she worries during the monsoon months but they have limited options and no alternative *"we just pray to God"*.

[12] 'Pakka' is the term used to describe a house constructed from cement, bricks and tiles.

Figure 6.13 Lalmata's house in Chaku. The family of six rent a single room in the ground floor of the house located at the bottom of the active translational slide in Chaku.

Case study: A relatively poor high caste family, "4 km Settlement" near Chaku

Bikram (42 years) and Lamu (40 years) live along the Arniko Highway approximately 4 km north of Chaku with their three non-literate and unmarried daughters aged 9, 15 and 16 (Fig. 6.14). Their fourth daughter, Chinimaya (11 years), works as a servant in Kathmandu. She visits her family once a year during festival time but does not remit any of her income. Bikram works in the nearby stone quarry earning NRs 100-150 per day (approximately NRs 3,000 per month[13]) and this is the household's only source of cash income. With no farmland to tend and Lamu and her daughters without work, the family were forced to take out a loan of NRs 12,000 to cover general expenses which they are still to repay. Unable to produce any of their own food, they rely solely on Bikram's income.

[13] Approximately £25 per month

Bikram was born in Larcha. He built a house by the road and farmed 4-5 ropanis (0.2-0.25 ha) of inherited land near Larcha bridge. The family were residing in Larcha at the time of the 1996 debris flow disaster and while they managed to escape, taking shelter in a nearby school, their house was badly damaged and their farmland destroyed. Concerned a debris flow would recur, Bikram and Lamu abandoned their house in Larcha. Bound to the road for employment opportunities, they had limited choice as to where they could settle. The family claim they received no compensation from the government for their loss of farmland as no family member was killed. Their decision to settle at “4 km Settlement” was ultimately determined by the availability of government land and labouring opportunities and the presence of their relatives who also live at “4 km Settlement” and in the nearby bazaar of Chaku. Lamu and her family are more than aware of the landslide hazard at “4 km Settlement” but they have limited choice for relocation.

Figure 6.14 Bikram, Lamu and their three daughters outside their house in “4km Settlement”, near Chaku

6.7.2 Choice

Case study: A relatively rich high caste household in Kodari

Ganesh (20 years) and his wife, Nima (21 years), migrated to Kodari in 2006 from the hill village of Nadung approximately two hours walk from the road. When I met Ganesh he had only been living in Kodari for two months. They decided to move to the roadside to set up a business. They rent one of the newly constructed houses in Kodari built from wood and tin (Fig. 6.15). From here Ganesh runs a small shop and canteen for the school children in Kodari. Ganesh tells me that in the two months they have been there business has been good. Back in Nadung, Ganesh's parents tend half of their family's land (approximately 15 ropanis; 0.75 ha), while the rest is sharecropped by another villager. Ganesh and Nima have no plans to return to the Nadung; they want to save money and move abroad, possibly to Belgium where Genesh's brother is living. Whilst aware that the Bhote Koshi River is undercutting the slope, they consider Kodari to be "*Okay at the moment*". They do not believe a landslide poses an immediate threat. In any case, they don't plan to be there for long; Kodari is step towards the future.

Figure 6.15 Ganesh and Nima's roadside shop in Kodari.

Case study: A relatively rich Sherpa household in Larcha

Shambhu (42 years) and his wife Yangi (40 years) live in a single story house in the roadside settlement of Larcha with their son (22 years). Their daughter is studying at a private school in Kathmandu, while their second son, works abroad in Korea. Shambu and Yangi made the decision to migrate to the roadside from the nearby hill village of Listi in 1996, when land became available after the debris flow disaster, for the business opportunities associated with the road. They run a small hotel/shop and have built a second house in the nearby bazaar of Tatopani which they rent for NRs 1,500 per month. In addition, Shambu receives remittance from his son in Korea. For Shambu, the decision to migrate was driven by the economic advantages associated with the road. Their relatively large landholdings back in Listi (40 ropanis; 2 ha) are now sharecropped by other villagers and they receive 6 months food. This case study, whilst a good example of migration driven by economic factors, is also interesting as it demonstrates landslides as agents of change. It was the occurrence of the debris flow which provided Shambu with the opportunity to buy the land. Other similar issues are discussed in Chapter 8.

6.8 Summary

There has been a long history of mobility and migration in the Upper Bhote Koshi Valley. The most significant recent changes have been driven by the construction of the Arniko Highway in 1967. In the absence of socio-demographic data, a baseline survey was conducted in order to determine the demographic characteristics of settlements both on and off-road. The survey showed that off-road populations are characterised by small farm households that focus on meeting their own subsistence needs. In contrast, on-road settlements are populated by migrant households. Here, there are fewer relatively poor households and business and day wage labour are the primary sources of cash income. This focus on economy reflects the primary factor driving migration; the social and economic benefits of a roadside location were repeatedly identified as the key pull factors driving migration to the road. In addition, low agricultural productivity and poor access to resources were the primary push factors.

Moving from the hill villages located near the relatively stable ridge tops to the valley bottom changes the type of landslide hazard to which households are exposed. Hill settlements are characterised by large, slow moving failures leading to frequent terrace collapse but little loss of life. Roadside settlements, on the other hand, are more vulnerable to acute landslides characterised by high movement velocities and long run-out distances; events such as the 1996 Larcha debris flow which claimed 54 lives. These findings suggest that risks do not map onto each other. Instead, new opportunities tied to roads cause traditional settlement patterns and their logics to be re-organised leading to increased risk in once sense (that from landslides and debris flows) but growing opportunities and reduced risk in other respects (for example through the access to services and the opportunity to generate a steady income for a more secure livelihood).

Chapter 7

Local Understandings of Landslide Hazard and Perceptions of Risk

'What would be needed to make us able to understand the risks that face us? – Nothing short of total knowledge (a mad answer to an impossible question)'

(Douglas and Wildavsky 1982)

7.1 Introduction

The previous chapter challenged the assumption that poverty-related pressures were the sole forces driving people to settle in high risk areas. It demonstrated that for the Upper Bhote Koshi Valley patterns of migration, although complex, have mainly been driven by the new economic and social opportunities offered by the road. Landslides, although a consideration, are not a primary factor determining whether or not a location is suitable for migration. This chapter aims to better constrain the decision-making process introduced here by investigating local people's understandings of landslide hazard and risk.

The chapter draws on new primary data sources: community meetings, household needs assessment, risk perception interviews and participatory mapping sessions undertaken in both the on-road (Chaku, Larcha and Kodari) and off-road (Marmin, Duguna and Listi) settlements in the Upper Bhote Koshi Valley. The chapter opens with a brief review of risk perception theory before turning to the findings from the community capacity and vulnerability assessment, and the assessment of household needs in order to determine the issues that are of concern to, and affect, the daily lives of individuals, households and communities in the Upper Bhote Koshi Valley. I then go on to examine how people conceptualise and understand the risks associated with landslide hazards specifically. Finally, I attempt to show how landslide risk relates to the everyday lives of individuals in the Upper Bhote Koshi Valley and how households balance risks and opportunities. Through this, I will situate risk perceptions within a wider framework of social and cultural processes and relations. This chapter will therefore address the following questions:

1. How are landslide hazards perceived and understood by rural households?
2. What socio-cultural factors influence these perceptions?
3. How is landslide risk viewed in relation to everyday livelihood issues and concerns?

4. How do households choose which risks to ignore and which risks to manage?

Building on Chapter 6, I argue that decisions about where a household chooses to live are crucial in the production of landslide risk, and that within this decision making process landslide risk perception plays a relatively unimportant role. A constructionist approach is taken (see, for example, Hannigan 1995) which acknowledges that people experience 'landslide hazard' in diverse, multi-faceted and complex ways (Macnaghten and Urry 1998). A combination of quotations, case studies and participatory maps are used to present the empirical material which is discussed in the context of livelihood (Ellis 2000) and wellbeing theory (Gough *et al.* 2007). I ground the risk perception discussion in the early work of Burton, Kates and White (1978) whose geographical research focused on understanding human behaviour in the face of natural hazards; and the anthropological research of Torry (1979b) and Mary Douglas (Douglas and Wildavsky 1982) who have explored the connection between social and cultural factors and risk perception.

7.2 Risk perception theory

The field of risk perception research is theoretically and methodologically diverse (Bickerstaff 2004). Psychological studies which initially defined the field have addressed the cognitive and attitudinal processes through which risks are interpreted and represented at the individual level, the ways in which particular types of hazard come to be viewed as risky (or not), and the factors that influence the acceptability of particular risks to experts and the public (Pidgeon and Beattie 1998). More recently, there has been a growing recognition of the need for a socio-cultural approach to understanding risk (Bickerstaff 2004). Proponents of this approach argue that perceptions of, and responses to, hazard and risk are formed in the context of a range of social, cultural and political factors. These approaches typically present an account of risk perception grounded in the social and cultural experience of everyday life (ibid). They recognise that a society is composed of many groups with very different attitudes towards, and appraisals of, what risk is and what values are relevant to making acceptability decisions (Pidgeon and Beattie 1998). While there has been some convergence between psychological and socio-cultural approaches to risk (for example, Peters and Slovic 1996; Finucane *et al.* 2000; Haynes *et al.* 2008), I am concerned here with socio-cultural understandings of risk.

Risk perceptions can be thought of as 'intuitive judgements' or 'attitudes' about hazards (Slovic 2000). The way people understand, interpret, perceive and assess risk can be seen to reflect traditional beliefs and values, knowledge, custom, religion, social structure, land tenure, length of time occupying a particular geographic location, and historical and modern experiences (Horlick-Jones *et al.* 2003; Harmsworth and Raynor 2005). Landslide risk perception is also based on human interaction with and dependence on the natural environment (Harmsworth and Raynor 2005). Heijmans (2004) identifies two aspects which make up local people's perception of risk: the possible exposure to danger and future damages (in this case from landslide hazard); and the capacities, options and alternatives for the exposed population, and the implications of their decisions to occupy a hazard prone area. However, few studies attempt to unpick the complex decision-making process in real social systems (Torry 1979a).

Social constructionist approaches to understanding the environment (see, for example, Hannigan 1995) have highlighted the way in which public concerns with environmental issues are 'balanced' or contextualised in terms of wider societal debates and concerns (Bush *et al.* 2002). This literature has identified what Walker *et al.* (1998) term a 'trade-off' between employment and the environment in economically dependent communities. Whilst this literature is primarily concerned with the environmental impact of industry in the developed world (see, for example, Wynne *et al.* 1993; Bush *et al.* 2001), the findings are equally applicable to developing country contexts. We return here to the discussion on 'choice' or 'voluntary' versus 'involuntary' risk taking (see, for example, Sjoberg 1989; Adams 1995; Caplan 2000; Ellis 2000) and the argument of Wisner *et al.* (2004) that if the closest situation in which people can attain economic opportunities is a hillside slum, people will locate there regardless of the landslide risk. Wisner *et al.* (2004) argue that in this situation neither 'voluntary choice' nor the notion of 'bounded rationality' (Burton *et al.* 1993) are applicable.

7.3 Empirical setting: the on-road and off-road settlements in the Upper Bhote Koshi Valley

As discussed in Chapter 4, the nature of the landslide hazard is seen to vary across the six case study settlements. The off-road settlements of Marmin, Duguna and Listi are characterised by large, slow moving failures while the on-road settlements of Chaku, Larcha and Kodari are at risk from fast moving landslides including debris flow hazards which are characterised by long run-out distances from distal source areas. This formed a basis on which I was able to compare the views, concerns and emphases of respondents. It has been suggested that perceptions of risk vary with proximity to the hazard; previous experience (either direct or vicarious); demographic characteristics including socio-economic status; and personality characteristics, that is, whether people feel they can control what happens to them (Lindell and Perry 2004). I was interested to explore how social and cultural factors influence the way in which lay people interpret and make sense of landslide risk in the Upper Bhote Koshi Valley.

7.4 The contextualisation of everyday risks in the Upper Bhote Koshi Valley

7.4.1 Community needs

Initially, I supposed that the rural Himalayan communities in the Upper Bhote Koshi Valley would be consciously living with landslide risk and that this would be a compelling issue to them. With the 1996 debris flow disaster in Larcha, the 2006 Chambang landslide in Marmin and the frequent reactivation of the Tatopani landslide, in my mind, how could they not? Landslides are having a direct impact on individuals, households and communities in the hills and the valley bottom. In the worst instance landslides cause fatalities and casualties but they also undermine livelihoods through the loss of agricultural land and the disruption of roadside trade and business activities.

However, despite this I soon discovered that the community perception was fundamentally different from my own view, which was largely concerned with the macro-scale geological hazard. I recall here a number of conversations I had during my time in the field. These can be encapsulated in the following quotation from a Sherpa woman in Listi village:

> *"Landslide awareness programmes wouldn't be effective. The land's too steep. There's no point because you cannot stop the landslides…..We need a literacy programme – none of the adults in the village can read or write. We need to improve the quality of education for our children – we only have six teachers for eight classes. We need a sanitation awareness programme – there aren't any toilets here in Listi. We need a reliable water supply. We've spoken to the VDC about this and we are hoping to get piped water"*
> (Interview with the Chairperson of the Listi Women's Group; female, Sherpa, 23 years, non-literate)

I soon became aware that this was the generally-held sentiment amongst communities in the Upper Bhote Koshi Valley; residents are more than aware that they live in a landslide prone area but landslides are placed in the context of wider societal concerns. Landslides are inevitable in such steep terrain but there have been only four significant landslide events since the 1950s, only one of which was fatal. Overall, I found landslides were viewed as a 'different issue' to the everyday pressures and hardships associated with economic and social insecurities. To the local people, these issues are hard to compare: one relates to the uncertainty associated with local hazard; and the other relates to the day to day livelihood insecurity which has an immediacy that is generally lacking in relation to landslide hazard.

Instead, villagers placed emphasis on their 'real' problems that reflect their individual, household and wider community needs.

Off-road settlements: Marmin, Duguna and Listi

Off-road in the settlements of Marmin, Duguna and Listi, communities identified their own vulnerabilities as food insufficiency; a lack of health care and sanitation facilities; no secondary schools and high levels of non-literacy amongst female villagers in particular; no access to market; and, a lack of opportunities to develop new skills (Fig. 7.1 and Table 7.1). With the exception of Marmin (which was affected by the Chambang landslide in the previous monsoon, June 2006), landslides were identified as a problem only when the respondents were asked about environmental hazards directly. In response, villagers talked about landslides damaging and destroying farmland and rock falls killing livestock. Other environmental hazards identified include stream and gully erosion, a particular problem in the settlements of Marmin and Duguna where active gullies wash away farmland during the monsoon months. However, participants (particularly the women) also identified a number of community capacities particularly in relation to the active community groups. The villages of Duguna and Listi have pro-active Women's Groups who coordinate activities in the villages independent of local government and NGO involvement including the establishment of emergency funds. The Community Forestry Groups are also active ensuring the sustainable use of the forest resource.

Figure 7.1 Analysing the community capacities and vulnerabilities with community members in Marmin.

Table 7.1 Community capacities and vulnerabilities identified by villagers in the off-road settlements of Marmin, Duguna and Listi

		Capacities	*Vulnerabilities*
Physical/material (Hazards, resources, skills)	*Marmin*	Primary school Resident teachers	Not enough food No medical facilities or toilets No secondary school No market or transportation to a market No opportunities to develop skills Environmental hazards: landslides, gully erosion, deforestation, pollution (rubbish and waste)
	Listi	The settlement is built on flat land and is safe from landslides The VDC is building a road from Listi to the highway Primary and lower secondary school TUKI (a Nepali NGO) provide teaching materials and scholarships for poorer children who would otherwise be unable to attend school Sub-health post, post office Temple – tourism potential	Lack of drinking water Only one staff member in the sub-health post - no midwife Teachers do not come to the village regularly No secondary school – few children continue their education No education for women who are non-literate No road or bazaar near by Lack of fertilizers or veterinary services No rice or water mill near by No irrigation for the farmland No bank for loans – rely on wealthier villagers who charge higher rates of interest No business opportunities Environmental hazards: farmland is prone to landslides
	Duguna	Well resourced primary school funded by a US NGO Resident teachers in the village Skill development - carpet weaving programme for women (sponsored by a US NGO)	The nearest sub-health post is 2 hours walk away in the roadside settlement of Tatopani No secondary school – the nearest schools are in Tatopani, Kodari and Barabise – poorer people cannot afford to send their children Protect the Duguna Palace and Fort – heritage site No satellite TV for the news Environmental hazards: • streams and gully damage and destroy farmland during the monsoon – require a bridge to cross the stream during the monsoon • rock falls – kill goats and damage farmland

Social/organisational (Relations and organisations among people)	*Marmin*	Savings and credit scheme	No active community groups in the village No government assistance
	Listi	Active Women's/Forestry Groups: • Emergency fund (each household contributes Rs20/month) – villagers can loan money at 2% interest per month • Clear footpaths of vegetation during the monsoon to help prevent leaches • Run awareness raising programmes e.g. the sustainable use of forest resources	
	Duguna	Active Women's Group • Emergency fund to help others • Goat rearing programme • Help people who are ill • Clear the footpaths and tracks Community Forestry Group – protect the forest resource Youth Group	The Women's Group needs a building/meeting place No government assistance
Motivational/attitudinal (The ability to create change)	*Marmin*	Unity – villagers help each other	
	Listi	The community works together to solve problems e.g. when a house in the village was destroyed by fire, villagers donated materials and helped to build a new house Members of the community help each other	Young people are migrating away – there are no young people in the village
	Duguna	Pro-active Women's Group – community helps each other	

Source: Village meetings May/June 2007

On-road settlements: Chaku, Larcha and Kodari

In the on-road settlements, participants identified a number of capacities. These were largely associated with road access (Table 7.2) and included the opportunity to set up a roadside business; employment opportunities; access to a reliable water supply, health care services, and primary and secondary schools. Social relations and organisations among and between people were found to be strongest in Chaku. Here respondents identified the Mothers' Group as a particular community strength. As the head teacher of Chaku Primary School explained:

> *"While the level of literacy is low, people are helpful and support each other"*
> (Male respondent, Brahmin, 40 years, educated to secondary level)

While there is no such community group in Larcha, villagers were keen to establish a group like the Women's Group in Duguna along with a Temple Construction Committee to build a replacement temple for the one destroyed by the debris flow. But the situation was somewhat different in Kodari, where the residents acknowledged that they did not know each other and there were no community groups or networks. While the Friendship Club was mentioned, few residents knew of the group or its activities. Residents of Kodari acknowledged that they were there primarily for the business opportunities and shared little concern for the community as a whole.

Villagers in Chaku and Larcha were concerned about the risk of landslide activity and, unprompted, identified landslides as a community hazard. Landslides were not, however, a priority concern. For the residents of Kodari, landslides were discussed in the context of the road which, due to slope deformation and ongoing subsidence, was in need of repair. While residents displaced by the 1981 landslide raised concerns over the continued movement of the slope, the new migrant community were more concerned with the practicalities of day-to-day life. Landslides were perceived to be of relevance only when they blocked the highway, and thus disrupted trade.

While the vulnerabilities and capacities of the on- and off-road communities differed, the situation regarding landslide hazard was much the same: landslides were regarded as only one of the many risks households and communities face. The actions of and discussions with the people made it very clear to me that they ***wanted to be there***, running their hotels and shops at the roadside, even if this meant living at the foot of a landslide prone slope or in the path of a potential channelised debris flow. As noted by Lavers (2007) in the context of rural development in Ethiopia: *'What, in the view of outsiders, is unquestionably of high priority, may not figure in the goals of residents of a particular community'* (p. 4).

Table 7.2 Community capacities and vulnerabilities identified by villagers in the on-road settlements of Chaku, Larcha and Kodari

		Capacities	*Vulnerabilities*
Physical/material (Hazards, resources, skills)	*Chaku*	Road access and bus services Opportunity to set up a roadside business e.g. a shop The flat land makes it easier to build houses Government funded primary school with resident teachers and a private boarding school Lower-secondary and secondary schools are nearby (Hindi) A new building has been constructed to house the sub-health post Water taps at the roadside Hydropower Plant – provides electricity and employment Day-wage labour e.g. carrying goods across the Nepal/China border Veterinary service Some irrigated farmland between the road and the river Clean environment	No bank for loans Steep cliffs are not cultivable and are too steep to graze cattle Poor quality soil for cultivation – low productivity Only maize and millet seem to grow here Forest resources are sometimes restricted No public toilets – some households have a toilet but many do not Environmental hazards: • Risk of landslides during the monsoon months – the houses by Chaku bridge are located in a vulnerable area and farmland at the bottom of Chaku is also at risk • Risk of floods (Chaku Khola and Bhote Koshi River) during the monsoon – farmland in Old Chaku has been washed away
	Larcha	Road access to the nearby bazaar of Tatopani Health post in Tatopani Government funded primary school Lower secondary and secondary schools in Tatopani and Hindi Water tap at the roadside Opportunities for day-wage labour Value of land has decreased following the debris flow	Limited cultivable land - steep cliffs No temple Debris flow destroyed farmland adjacent to the Bhairab Kunda Khola Environmental hazards: • Landslides at the top of the hill could cause another debris flow
	Kodari	Border town – opportunities for trade Road access to Kathmandu and Lhasa (China) Primary, lower-secondary and secondary schools (children can be educated from 6-15 years) Opportunities to set up a roadside business e.g. a shop, hotel Opportunities for day-wage labour e.g. carrying goods across the border Arniko Hotel/Resort constructed – potential source of jobs Public toilets Land is stable in comparison to other areas	The road is in need of repair – when it rains buses and lorries are unable to pass – the road needs sealing Arniko Hotel/Resort has closed – hotel at the roadside is subsiding and tourists do not stop here Deforestation – trees are being cut down to build houses at the roadside (houses are no longer being built in the traditional style) Pollution – rubbish is a big problem Environmental hazards: • Undercutting by the Bhote Koshi River

Social/organisational (Relations and organisations among people)	*Chaku*	Active Mothers' Group: • Emergency fund (each household contributes Rs20/month) - villagers can borrow money • Awareness raising programmes to stop deforestation, alcohol abuse and to empower women Chaku Club - collecting rubbish NGOs are sponsoring talented students DDC and Canadian Government have funded the CEAMP Project in Marmin VDC to identify hazards	No government assistance – the VDC and DDC do not help the people
	Larcha	Villagers help each other e.g. after the debris flow disaster	No government assistance – they only visit when something happens No community groups
	Kodari	Friendship Youth Club • Keeping Kodari and Liping clean	No assistance from the VDC or DDC Forest User Group disbanded due to a lack of interest from the community
Motivational/attitudinal (The ability to create change)	*Chaku*	Low levels of literacy but people are helpful and support each other e.g. providing accommodation to households affected by the Chaku landslide Villagers recognise the importance of education and literacy Pro-active community	
	Larcha	Residents are keen to set up a community group	
	Kodari		Householders' do not know each other in Kodari – people are here for the business opportunity No interest in the natural environment

Source: Small group meetings, October 2006

It is certainly misleading to perceive these roadside settlements as high-risk areas filled with marginalised poor people living on the brink of disaster, although this is precisely what the western discourse, and indeed the Nepali discourse, tends to assume. In the Government of Nepal's Tenth Development Plan, disasters are attributed to both the physical environment and socio-economic processes that generate vulnerability:

> *'Because of the geographical and geological structure together with the haphazard settlement, increasing population, economic backwardness, illiteracy, and lack of knowledge the manmade disaster is increasing day by day.'*
> (National Planning Commission 2002b: 431)

From a landslide hazard perspective, the roadside settlements are indeed located in areas of high hazard. But, the 'emic' reality for those 'at risk' is quite different.

In considering the wider risks to individual livelihoods it becomes clear that these roadside settlements are not as dangerous or disaster prone as an outsider, such as myself, may think. Initially I labelled these areas as the home of marginalised people with little choice but to dwell in 'risky' locations (a reflection of a series of root causes and dynamic pressures discussed in Chapter 6). Instead, I unearthed a counter discourse. Put simply (and of course there is a great diversity of individual experiences) risks do not map onto each other. In moving to a landslide prone area some risks are increased (e.g. the risk of landslide activity), others are reduced, and in the context of the everyday risks faced by the household, these are comparatively safe areas to occupy: households have access to a clean and reliable water supply; are able to find off-farm employment and make enough money to meet their subsistence needs; they can send their children to the nearby public school; and have access to the local health post.

Many of the case study households were found to have a very astute view of risk at the micro-scale. What at first appeared to be 'risky actions', for example, constructing a house at the bottom of a steep, unstable slope prone to failure, were in fact well thought out actions with clear underlying reasons. For example, as a resident of Larcha explained:

> *"Village life is difficult and Larcha offers better opportunities for my children. We built a house 13 years ago in Larcha. There are business opportunities here and our relatives are here as well."*
> (Female respondent, Sherpa, 37 years, non-literate)

In general, the sample households adopted 'risk-averse' or 'risk-avoiding' strategies but these were undertaken in the context of the everyday risks they face. Whilst geological hazards were part of this, they were not prioritised. These findings affirm those of the International Karakorum Project (Miller 1984). As summarised by Hall (1999): *'in effect they* [the case study communities in the Karakorum Himalaya] *accepted the risk from an infrequent natural hazard event in order to reduce the risk to their everyday economic needs'* (p.3).

Pidgeon *et al.* (1992) make a distinction between acceptability and tolerability of risk. Tolerability denotes the trade off that people make as they may not accept risks but tolerate them to secure certain benefits. However, I argue that in the case of the households and communities in the Upper Bhote Koshi Valley, the distinction between acceptability and tolerability is blurred. Are households tolerating the risk at the roadside to secure the benefits associated with roadside living, for example, business opportunities, access to day-wage labour, or secondary education; or, are they accepting the risk? Either way, local interpretations should not be viewed as a misunderstanding of the potential severity of the macro-scale landslide hazard, but as indicative of a different understanding, one which situates landslides in the context of a range of social and environmental factors and sees it as a part of an interconnected bigger problem regarding livelihood security.

7.4.2 Household needs

At the end of the household survey, respondents were specifically asked to list the three main and urgent needs of their household i.e. **the things the respondent felt were necessary for their lives**. This was a deliberately open-ended question. It was anticipated that respondents would include both intermediate needs[1] and their goals or aspirations. While the respondents were not explicitly asked to rank their needs in order of priority, the findings suggest they did undertake some form of prioritisation. For example, for the off-road households, access to a latrine and daily food were mainly first order priorities, whilst a reliable water supply and firewood featured as second or third order concerns.

Three of the sampled off-road households (two in Duguna and one in Listi) responded to this question with no immediate household needs[2]. In all three cases the households were able to meet their own subsistence needs and produce food for 12 months of the year. For the remaining 95 households sampled, the main and urgent needs of the sampled off-road households (Table 7.3) were subsistence based. As observed by Lavers (2007) in rural Ethiopia,

[1] Doyle and Gough (1991) identify eleven intermediate needs as part of their *'Theory of Human Need'*: nutritional food and clean water; protective housing; a non-hazardous work environment; a non-hazardous physical environment; safe birth control and child-bearing; appropriate health-care; a secure childhood; significant primary relationships; physical security; and appropriate education.

[2] I acknowledge, here, that all households will have some needs they just may not have expressed them in response to the survey question.

people with access to limited resources are forced to give certain goals priority depending on current exigencies.

Table 7.3 Household needs and goals as identified by informants from case study households in the off-road settlements of Marmin, Duguna and Listi

		Number of times and order mentioned			
	Household needs	*1st*	*2nd*	*3rd*	*Total*
Subsistence	Daily food	19	12	8	39
	Firewood	7	17	14	38
Health/	Access to a latrine	25	11	10	46
sanitation	Medical treatment	8	16	15	39
	Reliable water supply	2	10	10	22
	Access to drinking water	1	3	2	6
	Care for the elderly	1		1	2
Agriculture	Livestock	2	1	2	5
	More farmland to meet subsistence needs	4			4
	Agricultural land (landless households)		1	1	2
	Gabion walls to protect farmland	1		1	2
	Access to seasonal farm labour	1	1		2
	Irrigation		1		1
	Veterinary care for animals			1	1
Housing	Build a new house	4	1	1	6
	New roof for the house	3	1		4
	Repair the house	1	1		2
	Build a house of their own			1	1
	Access to materials for house construction	1			1
	Save money to build a house		1		1
Income	Reliable income	5	2	2	9
	Employment opportunities	1	2	2	5
	Clear debt		3	1	4
	Access to loans with better rates of interest			1	1
Education	Secondary education for children	2	5	4	11
	Education for children	3	3	2	8
Other	Sugar, salt and oil	1	1		2
	Access to shops		1	1	2
	Fruit and meat	1			1
	Clothing			1	1
	A road connecting the village to the highway	1			1
	Fear of death	1			1
	No needs identified	3	4	17	24
	Total	*98*	*98*	*98*	

Source: Household surveys, May/June 2007

Having access to a latrine was the top priority (identified by 48% of the sampled households). This was followed by food security (41%) reflecting the subsistence food deficit in the Upper Bhote Koshi Valley where only 10 of the sampled off-road households meet their subsistence needs through agricultural production (Household surveys, May 2007). This was closely followed by medical treatment (a need cited by 41% of the sampled households) and access to firewood (40%). Access to firewood was a particular concern for female respondents. Local forest user groups are zoning the community forest to encourage sustainable use of the forest resource. As a result, women have to walk for up to three hours to collect firewood (*pers comm.*, Head of the Women's Group, Listi). The fifth household need was access to a reliable water supply (23%). This was a particular problem for villagers in Marmin where the water pipes are frequently blocked (Community profile, Marmin, May 2007) and Listi where there is only one water tap for the whole village and the water is unsuitable for drinking (Community profile, Listi, May 2007).

Secondary education was ranked as the sixth overall need by the sampled off-road households (12%). While this figure may appear surprisingly low, it does reflect existing enrolment rates of young people in lower secondary (11-13 years), secondary (14-15 years) and higher secondary school (16-17 years). Secondary education was considered important for the younger generation for the opportunities it opens up beyond subsistence agriculture. Fifty six percent (n = 10) of girls and 75% (n = 15) of boys aged 11-13 years were enrolled in lower secondary education; 50% (n = 6) of girls and 53% (n = 9) of boys aged 14-15 years were enrolled in secondary education; and 43% (n = 6) of girls and 40% (n = 6) of boys aged 16-17 years were enrolled in higher secondary education (Household surveys, May 2007). With the exception of lower secondary school, we therefore see a near gender parity in school enrolment. The identification of secondary education as a household need most likely reflects the absence of a secondary school in the village (see Table 7.1) and the need for young people to travel and often live outside the village at the roadside in order to attend secondary school, which some households are unable to afford.

Table 7.4 shows the responses of the sampled households in Chaku, Larcha and Kodari. Only one of the sampled roadside households (the household of the VDC Secretary) did not identify any household needs in response to the survey question; while 85% of sampled households identified two needs; and 55%, three. With their subsistence needs met (only 6% of the sampled roadside households identified daily food as an urgent need; 3% medical treatment; and 1% firewood; while access to a latrine and a reliable water supply did not feature),

Table 7.4 Household needs and goals as identified by informants from the on-road settlements

		Number of times and order mentioned			
	Household needs	*1st*	*2nd*	*3rd*	*Total*
Subsistence	Daily food		1	3	4
	Good diet for the children		1		1
	Access to firewood		1		1
Health/ Sanitation	Health		1	1	2
	Medical treatment	2			2
	Care for the elderly family members			1	1
Agriculture	Livestock	1	1	1	3
	Agricultural land to meet subsistence needs		1		1
	Reliable harvest			1	1
Housing	Buy land and construct a house by the road	10	4	2	16
	Build a new house	4	3		7
	Build a house in a bigger bazaar	2	3		5
	Build a bigger, modern house	3	1		4
	Money to build a house		3		3
	Relocate to a safer area which is not landslide prone	2			2
	Extend house	2			2
	Repair the house	1			1
	Construct a second house		1		1
Income	Reliable income	10	4	4	18
	Expand business	6	7		13
	Clear debt	4	3	1	8
	Good job for son		3	1	4
	Good job for husband	1	1		2
	Overseas employment	2		1	3
	Own a roadside hotel/shop			3	3
	Set up a roadside business (transport, trade etc.)	2	1		3
	Earn more money	2			2
	Good job for children/grandchildren	1			1
	Construct a second house to let		1		1
	Save money	1			1
	Receive money owed	1			1
	Retire from work	1			1
Education	Better education for children	4	9	7	20
	University education for children	1			1
Other	Happy and healthy life	2	2	9	13
	Better future for children	1	3		4
	Pilgrimage		1	1	2
	Sons to marry			1	1
	Help others		1		1
	No needs identified	1	10	30	41
	Total	*67*	*67*	*67*	

roadside households were seen to formulate goals beyond the requirements of day-to-day survival.

The top priority for the roadside households was securing a good education for their children (this was cited as a main need by 30% of the sampled roadside households). Aware of the relevance and importance of education, young people are encouraged to gain their School Leaving Certificate[3] and to complete the two-year college course that follows. If possible, children are sent to private boarding schools in Kathmandu for a better education. Out of the 67 sampled roadside households only one household did not send their children to primary school because they could not afford to do so. Across the remaining households we see gender parity in primary school enrolment and near gender parity in secondary schooling with 80% (n = 8) of girls and 92% (n = 11) of boys aged 11- 13 years in the sampled households attending lower secondary school; and 78% (n = 7) of girls and 86% (n = 6) of boys aged 14-15 years attending secondary school. Emphasis was still placed on securing a good job for male members of the household (a need identified by 9% of the sampled roadside households), reflecting wider cultural norms and household patriarchy. This is reflected in the enrolment figures for higher secondary education where 46% (n = 6) of girls and 67% (n = 8) of boys aged 16-17 years are studying for their College Leaving Certificate (CLC).

With the shift in emphasis from subsistence agriculture (only 7% of the sampled roadside households identified a farming related need), 27% of the sampled households identified a reliable income as a main and urgent need. Securing a reliable household income from day wage labour or through the establishment of a roadside business is essential for roadside households. But, what emerged from the interviews was a desire for betterment as reflected by the incremental changes in respondents' aspirations. Households relying on day wage labour as their main source of cash income aspired to owning their own roadside shop/hotel or establishing a roadside trade or transport business (9% of the sampled on-road households); while households with established roadside businesses wanted to expand their businesses (19% of the sampled on-road households). Similarly, for households occupying government land or renting a property at the roadside, there was a strong desire to buy land and construct their own house by the road (24% of the sampled on-road households). For households who already own a house at the roadside, they wanted to construct a bigger, better, more modern house in a bigger roadside bazaar such as Barabise and ultimately Kathmandu.

[3] The School Leaving Certificate (SLC) is the final examination in the secondary school system of Nepal. The examination is taken after completing the tenth grade (15 years).

What is most striking, however, is that 19% of the roadside respondents identified a happy and healthy life as one of the main and urgent needs of their household, implying that their intermediate needs, at least in the context of this question, had been met. As seen through the case studies in Chapter 6, the occupation of landslide prone areas cannot be understood in the context of poverty and marginalisation alone. I draw here on the work of Ian Gough and Allister McGregor on wellbeing in developing countries. While the exact meaning of the term 'wellbeing' remains contested (Gough *et al.* 2007)[4], it is a useful concept when attempting to understand a household's apparent vulnerability. At first it may appear incongruous to discuss wellbeing in relation to 'vulnerable communities'. However, as summarised by Gough *et al.* (2007):

> *'Poor people in developing countries strive to achieve wellbeing for themselves and their children. For the poorest and in the worst instances, this will largely be a struggle to limit their extent of illbeing and suffering….*[while] *the non-poor in developing countries can often experience what appear to be high levels of life satisfaction'* (p. 3).

In the on-road settlements of Chaku, Larcha and Kodari, we see examples of landless households living in rented houses at the roadside in highly vulnerable locations. However, they have access to day wage labour and the opportunity to send their children to school. It is striking that some of the roadside households experience what appear to be high levels of life satisfaction despite living in high risk areas – at least in the context of landslide hazard.

7.4.3 Landslide vulnerability

Only four of the sampled households identified landslide mitigation and vulnerability reduction as a main and urgent household need. Two of the roadside households identified the need to relocate to a safe area which is not exposed to landslide hazard. Similarly, off-road, only two households identified the need for gabion boxes to protect the terraces from landslide hazards. This finding is particularly salient given the targeting of landslide affected households in the survey. Respondents may alter their response according to what they believe the researcher may be able to supply (Lavers 2007), for example, mention of gabion walls, check dams or even resettlement opportunities. However, this was certainly not the case, with only 2% of respondents (n = 4) mentioning landslide hazard in the context of their household needs, suggesting that, when examined alongside the household survey and risk perception interviews, these data provide a reliable insight into respondents' 'felt needs'. Having examined how landslide risk is viewed in relation to everyday livelihoods concerns, the

[4] Gough *et al.* (2007) view wellbeing as an umbrella concept that takes account of both objective (externally approved, non-feeling features of a person's life e.g. morbidity) and subjective wellbeing (feelings of the person whose wellbeing is being estimated).

remaining chapter focuses on perception of landslide hazard and risk specifically. In particular, how landslide hazard is perceived and understood; and the socio-cultural factors influencing these perceptions.

7.5 Perceptions of landslide hazard in the Upper Bhote Koshi Valley

The fact that few respondents highlighted landslide hazard as an issue might be taken to reflect the fact that they are unaware of the geological hazards that surround them. To determine to which extent this was the case, I was interested to explore people's knowledge of the geophysical processes and the causes and triggering mechanisms of landslide activity in the Upper Bhote Koshi Valley (for an introduction to the nature of landslide hazard in the Upper Bhote Koshi Valley see Chapters 3 and 4). I begin by exploring local understandings of the geophysical hazard including the causes and triggering mechanism of landslide activity before moving onto local understandings of risk and the likelihood of slope failure.

7.5.1 Language

In Nepali the word for landslide is *pā hīro*[5]. Directly translated, *pā hīro* means 'soil erosion' and is used to describe the transportation of material (rock, debris or soil) down slope. While specific words exist in the Nepali language for rock fall (*dhunga khasne* and *chhatane ghharne*) and debris flow (*ledho pā hīro*), *pā hīro* is the generic term used to describe all types of mass movement (Table 7.5). No distinction is made between the type of material (rock or soil), the type of movement (fall, slide or flow), or the speed/run-out distance. *'Pā hīro'* is used to describe the general process of mass wasting including landsliding, erosion and gullying. Respondents mainly associated landsliding with soil erosion, shallow slope failures and the movement of terraces. As a result, I used the term *'pā hīro'* in my interviews.

Table 7.5 Key Nepali terms defining landslide hazard

Nepali word	*Definition*
Pā hīro	The transportation of rock, debris or soil down slope
Dhunga khasne / chhatane ghharne	The detachment and downward movement of rocks from cliff faces
Ledho pā hīro	Rock, soil and other material combines with water to form a slurry which moves down slope

Source: Household interviews, October 2006

[5] *Pā hīro* has the same meaning in the Tamang language but in Sherpa the word *'tokpa'* is used to describe both soil creep and large mass movements. In the Newari language *'chalā'* is used in the same collective way as *pā hīro* to describe landslides and erosion. With the majority of interviews conducted in Nepali, I focus my discussion here on the Nepali language specifically.

Landslides are viewed as hazards - *sankat* or *khatara* which means 'something dangerous'. People talk of the risk (*jokhim* – the 'uncertain outcome') of a landslide occurring. *Jokhim* is usually associated with a negative outcome, and as such, is synonymous with the terms danger, insecurity and the unknown.

7.5.2 Local knowledge of the geophysical hazard

Overall, landslide knowledge was high, implying that a lack of knowledge is not the main reason that landslide hazard is not cited as a key concern. Most people in the Upper Bhote Koshi Valley have direct experience of landslide activity, a reflection of the steep mountain environment in which they live (see section 7.4.1 and Chapter 6 for detailed case studies). Landslides are recurring events forming part of what Schmuck-Widdmann (1996) terms a 'life-world'. As noted by one resident:

> *"Landslides happen every year and damage our farmland. It's normal life for us."*
> (Male respondent, Sherpa, 60 years, non-literate)

Households and communities have long been living with landslide hazard and as a result, landslides are a normal part of everyday life. As noted by Cool (1983 cited in Blaikie and Brookfield 1987): *'flooding, landslips…and occasional earthquakes are taken in stride. With only hand tools and simple bullock drawn ploughs, but with enormous fortitude, the mountain farmer rebuilds, re-ploughs, reseeds and survives'* (p.42). While this may seem a rather romantic interpretation of the environmental hazard scenario in rural Nepal, it does encapsulate the resilience of a mountain population exposed to relatively frequent landslide hazards.

Elsewhere, research has demonstrated local understanding of geophysical processes (see, for example, Johnson *et al.* 1982; Bjonness 1986), knowledge based on firsthand experience, observation and accumulated knowledge. As noted by Johnson *et al.* (1982) *'this knowledge is not an understanding of geomorphic processes as conceived by Western society, yet it represents an understanding of the immediate physical causes of erosion, gullying, landslides and floods'* (p. 182). In her study of indigenous and engineering knowledge of the chars[6] in Bangladesh, Schmuck-Widman (2001) found that descriptions of erosion and sedimentation processes by engineers and the char-people, both separately and in dialogue with each other, showed a similar understanding of these processes: *'both knowledge cultures presently have the same level of knowledge concerning prediction of river behavior'* (p. 197). I was therefore interested to explore local knowledge of landslide hazard in Nepal to see if this same level of

[6] Newly accreted land.

understanding applied. For this, I draw on a range of primary data sources including semi-structured interviews, walk-over surveys and participatory maps.

Landslide causes and triggering mechanisms

In the household interviews, local people indentified a range of causes of landslide activity including geological, morphological and human causes. These have been tabulated based on the USGS classification introduced in Chapter 2, Section 2.2 (Table 7.6).

Table 7.6 Landslide causes identified by residents of the Upper Bhote Koshi Valley

Geological Causes	*Morphological Causes*	*Human Causes*
Weak materials Weathered materials	Steep slopes Fluvial erosion of the toe of the slope Gully erosion Landslide dams	Excavation of the slope during road construction Deforestation Irrigation Mining/quarrying

Source: Household interviews, October 2006 and May 2007

While local people do not talk about slopes in terms of the mechanisms or driving and resisting forces as geologists and geomorphologists do, they clearly understand the impact of factors such as steepness of slope, the internal cohesion of the slope material, the weight or loading on the slope and the moisture conditions.

Geological causes

Respondents talked of the weak/fragile slope material which characterises the Upper Bhote Koshi Valley:

> *"Our hills are not hard rock, the soil simply disintegrates"*
> (Female respondent, Sherpa, 48 years, non-literate).

This is a geomorphologically accurate description of the loosely consolidated colluvial deposits in the Upper Bhote Koshi Valley which have a low ratio of clay combined with silt, sand and angular gravel (DoR and SDC 1989). Again, while local people do not use the terms 'cohesion' (the force which holds sediment particles together) or 'internal friction' (the resistance of particles of granular sediments to shearing), this is what they are describing. The following quotation and published definition of a debris flow illustrate this:

> *"The rainwater washes the mud away. The slope material loses its cohesive power. Without the mud, the stones and boulders move down the hill."*
> (Female respondent, Kami, 27 years, non-literate)

> *'Loose slope material becomes saturated, resulting in a loss of cohesion and internal friction between the granular particles, so that an unstable slurry mixture is produced'* (Smith 2001: 187)

Morphological causes

Residents of the Upper Bhote Koshi Valley are more than aware that the steep relief makes the area prone to erosion and landsliding. During walk-over surveys and the participatory mapping exercise, participants classified particular areas as vulnerable based on the steepness of slope and the soil characteristics. What is particularly surprising, given the scarcity of cultivable land, is that settlements in the valley are located on the available flat land while the steep, landslide prone areas are used for cultivation. This is in contrast to the findings of the International Karakorum Project where Moughtin (1984) observed that the best land in the Yasmin Valley was reserved for agriculture while houses and schools were often located on landslide-prone slopes. This perhaps reflects that the relative income from the road is greater than that of the fields. Even though it is the best land, it appears to be less financially viable to farm it.

For the residents of the roadside settlement of Kodari, fluvial erosion of the toe of the slope by the Bhote Koshi River was deemed the main cause of slope instability in the area. This was identified as a significant problem by the recent migrants to Kodari and also the long-term residents of the settlement. However, it was the residents displaced by the 1981 landslide who were able to explain the cause of the flood event which triggered the slope failure more than 20 years ago (Figure 7.2). Residents made a clear link between a glacial lake outburst in Tibet, flooding in the Bhote Koshi and the incision of the slope although the interpretation of the physical process was not always scientifically correct. For example:

> *"The* [1981] *flood was caused by glacial ice falling into the lake in Tibet"*
> (Male respondent, Kami, 73 years, non-literate)
>
> *"A glacier in Tibet shifted causing the lake to burst"*
> (Female resident, Kami, 59 years, non-literate)

However, local people were very much aware of the impact which flood waters were having on slope stability through the removal of toe support:

> *"When the river is in flood, the flow of the river increases and it strikes the toe of the slope causing the land to move"*
> (Male respondent, Chhetri, 20 years, educated to College Certificate level)
>
> *"The landslide was triggered by the glacial lake outburst flood. The Bhote Koshi undercut the slope….The flood waters struck the bottom of the slope causing the land to shift down."*
> (Female respondent, Kami, 59 years, non-literate).

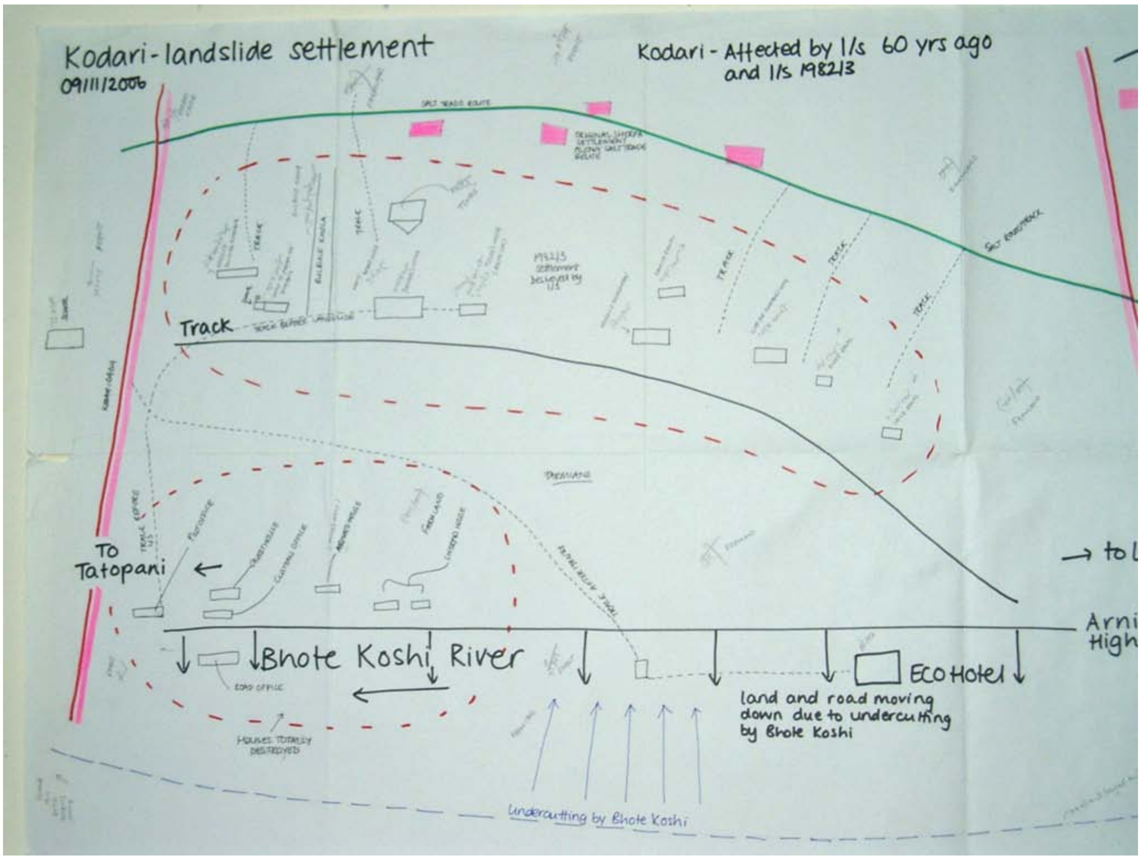


Figure 7.2 Participatory landslide hazard map of the roadside settlement of Kodari. The sketch map shows the location of the four Sherpa houses along the salt trade route destroyed by a landslide more than 60 years ago and the settlement that was rebuilt. Participants identified undercutting or incision by the Bhote Koshi River as the main cause of slope instability in Kodari and the trigger of the 1981 landslide.

The impact of fluvial erosion has been observed elsewhere in the Upper Bhote Koshi Valley. A 2 km stretch of road to the north of Chaku is particularly vulnerable. Here river incision has caused the removal of lateral support at the foot of the slope resulting in the downward movement of the slope and the displacement of the road. “4 km Settlement”, located along the new road alignment, has been affected by river incision with residents reporting undercutting of the slope below their houses.

As discussed in Chapter 4, the 1996 Larcha debris flow was caused by a temporary landslide dam which was subsequently breached inundating the village of Larcha. This was articulately explained by a yak farmer who witnessed the event upstream (Fig. 7.3):

> *“There are three streams - one from the Bhairab Kunda Lake and two others. Heavy rain carried mud and wood and blocked the main stream channel. The temporary wall suddenly broke and the debris flow occurred in Larcha. When I’m in the hills with the yak, I see debris in the stream. It could happen again but it’s a business area so people live there.”*
> (Male respondent, primary education, Sherpa, 40 years)

Figure 7.3 Participatory mapping with a pastoralist in Duguna village. Our informant was explaining the cause of the 1996 Larcha debris flow.

However, while the present day residents of Larcha are aware of the causes of the disaster (Fig. 7.4), the event surprised migrant households in 1996. Exposure to new and unfamiliar hazards at the roadside and an absence of inherited or locally specific knowledge can result in people failing to recognise early warning signs associated with particular hazard events. In this case, the stream stopped flowing. However, unaware of the temporary landslide dam upstream, the residents did not perceive this to be a warning sign of a potential debris flow disaster. As one survivor explained:

> *"It had been raining for two to three days before and at 4pm the water flow stopped in the stream…..we just thought the water had stopped on the top of the hill."*
> (Female respondent, Sherpa, 37 years, non-literate)

Gully erosion was a further problem identified by residents in the Upper Bhote Koshi Valley, particularly in the hill villages of Marmin and Duguna where perennial streams which are active during the monsoon months erode farmland. With their farmland located between a network of gullies, villagers were more concerned by gully erosion and flooding than by landslide activity.

Human causes

Respondents showed a good understanding of the links between deforestation and landsliding. This most likely reflects the implementation of a number of community forestry projects with the aim of conserving the forest resource. As two residents explained:

> *"*[The] *monsoon rains trigger landslides. During the monsoon the water comes gushing down the slope. Deforestation is a main cause. The roots of the trees hold the soil together. Without trees, the rain sweeps the soil away."*
> (Female respondent, Sherpa, 22 years, educated to secondary level)

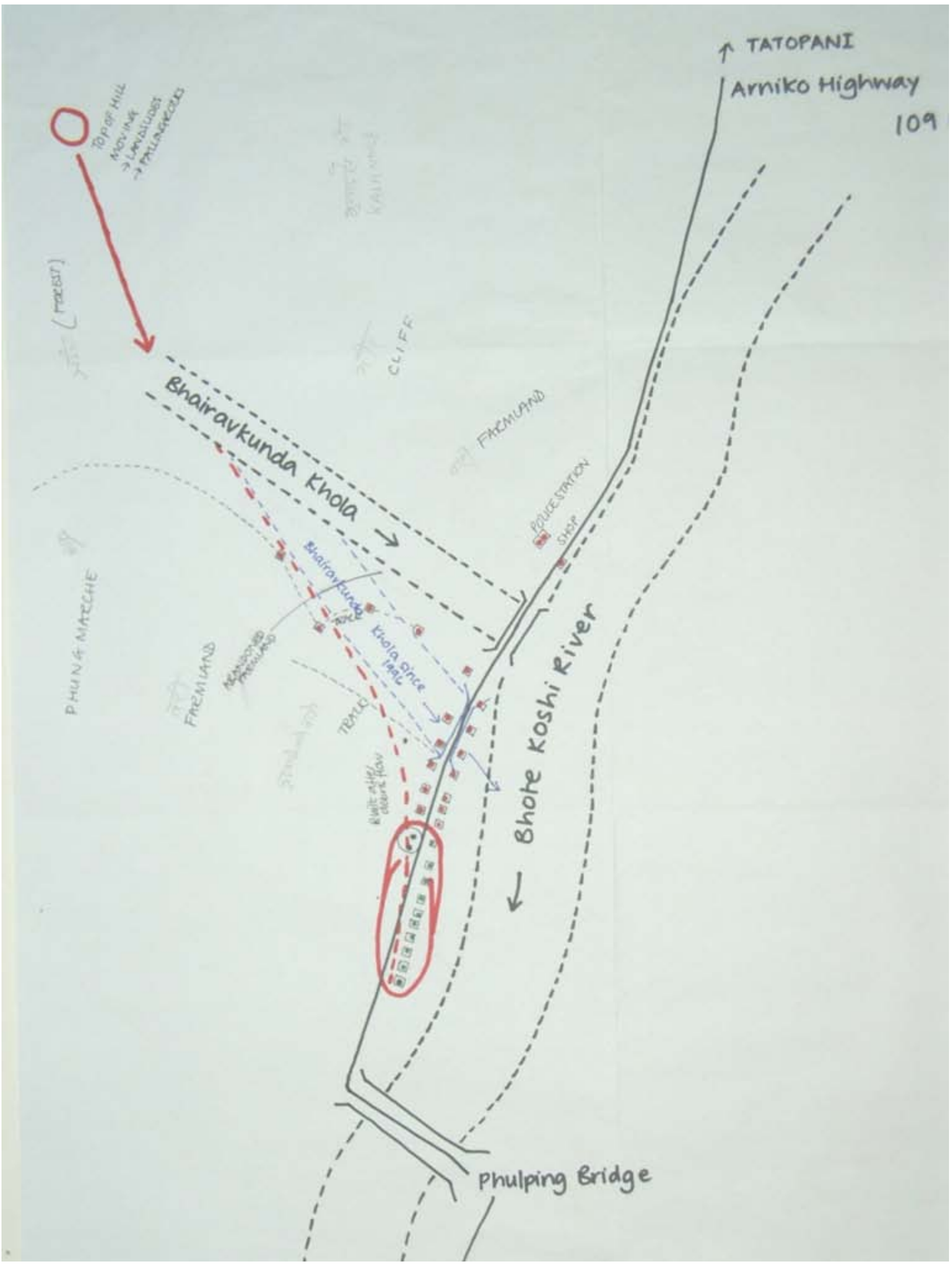


Figure 7.4 Participatory landslide hazard map of Larcha showing the settlement before and after the 1996 debris flow event. Houses and buildings coloured red were destroyed by the debris flow while the green houses were damaged but have since been repaired and are currently occupied. Participants noted that the Bhairab Kunda Khola has changed its course following extensive aggradation following the debris flow. Farmland previously used to cultivate maize and millet has been destroyed and abandoned.

> *"The roots of the trees help to bind the soil. So, in the absence of trees, soil looses its binding agent and when it rains the loose soils and rocks are washed away by the force of the water"*
> (Male respondent, Newar, 15 years, educated to secondary level)

Similarly, the quarrying of stone and slate for house construction and commercially for export to Kathmandu, was identified as a further cause of landslide activity. Residents pointed out the visible scars on the landscape caused by quarrying, an activity which a number of respondents linked to the 2006 Chambang landslide. A teacher in Marmin explained:

> *"Quarrying stone - removing the slate from the rocks causes landslides and deforestation - the roots of plants bind the soil preventing erosion. The* [2006] *Chambang landslide was caused by quarrying. Most of the people of Marmin are poor and uneducated. They do not know the value of the forest. The local people of Marmin rely on the stone quarry as a source of income. But the removal of stone weakens the land and then landslides occur."*
> (Male respondent, Chhetri, 38 years, educated to College Certificate level).

The negative impacts of quarrying on slope stability were, in fact, noted by many non-literate villagers, but the value of the stone and slate was such that they continued the quarrying activities. This activity was not, therefore, a reflection of ignorance as the high caste respondent above suggests. The environmental impact was known and understood but the stone is an important source of household income. This again reinforces the priority differential.

Irrigation was also identified as a possible cause of slope instability particularly on 'khet' land (irrigated paddy land) where the permanent saturation of soils can lead to slumping and the collapse of individual terraces or entire hillsides. However, with the majority of cultivated slopes in the Upper Bhote Koshi Valley being rain-fed, irrigation was not identified as a cause of landsliding in the on-road or off-road settlements.

Triggering mechanisms

Residents identified the main trigger of landslides in the Upper Bhote Koshi valley as heavy or persistent rainfall with the majority of landslides occurring during the monsoon months (June to September). When asked how rainfall triggers landslides, reference was made to the slope material being washed away, akin to a process similar to sheet or gully erosion. Respondents also talked about the slope material being unable to withstand the additional weight from the rainwater, which again causes the material to move down slope. This was the main explanation given for the collapse of agricultural terraces as illustrated in the following quotation:

> *"The heavy monsoon rains cause the soil to slide down. The terraces move down slope and rocks fall from the top of the hill. Other storms* [cloud bursts] *also trigger landslides. The* [1996 Larcha] *debris flow was caused by a landslide at the top of the hill which blocked the stream."*
> (Male respondent, Tamang, 57 years, educated to primary level)

Only one respondent identified earthquakes as a landslide trigger. This respondent, a 43 year old male of hill tribe ethnicity, observed a rock fall during an earth tremor, along with the collapse of old houses and trees. Generally, respondents were unaware that destructive earthquakes are possible in the Valley. While tremors are common (reflecting the position between the Main Frontal Thrust and the Main Central Thrust Fault – see section 2.4.3), there has not been a significant earthquake in the region within living memory of the population. In fact, with events outside the Kathmandu Valley being largely unrecorded prior to the early 1990s, there are no formal records of earthquake activity. Inquiries yielded statements like: *'large earthquakes don't happen here'* and *'earthquakes happen all the time but are not destructive'*. Even the large tremors (Richter magnitude c. 3.0 to 4.0 (USGS)) experienced during my time in the field, was considered *'normal'* and *'nothing to worry about…the ground just moves sometimes'*. Respondents were unable to explain the cause of earthquakes – *"I don't know about earthquakes. You cannot see them, you can only feel them"* (Female respondent, Sherpa, 23 years, non-literate) – they are simply viewed as something that occasionally happens. This finding is perhaps unsurprising given that only 4% of the fatal mass movements recorded worldwide between 1994 and 2004 were triggered by earthquake activity (Oven 2005) (see Section 2.3). It does, however, show that respondents do not anticipate the occurrence of a high magnitude earthquake event in the future.

7.5.3 Supra-natural understanding

Supra-natural explanations for landslide activity were also given. Landslides were explained as the work of the Gods who reside in the mountains. The Gods trigger landslides when angered by the sinful acts of the community and the general disrespect of the natural environment. Landslides were therefore often seen as punishment. Popular Hindu beliefs link the Gods with giant snakes (nags) that live below the ground and when the Gods are angered, the snakes move, triggering a landslide:

> *"The Snake Gods and Goddesses live here. If people do not keep the land clean and tidy or if they chop down trees/quarry stone, the Deities move to another place triggering a landslide…..We worship the Gods to make the landslide stop. The debris flow disaster in Larcha was caused by the residents of Larcha sinning. The Gods responded by triggering a landslide.*
> (Male respondent, Sherpa, 42 years, educated to primary level)

Little difference was noted between Buddhist and Hindu belief systems but respondents who were more sceptical about religion tended to explain the phenomena as 'natural'. Few households have, what Pigg (1996) terms, 'blind faith'. Supra-natural understanding does not go unquestioned by the sample households but equally the ideas are not totally dismissed. Supra-natural beliefs and explanations seem to be inconsistent with local knowledge of the physical environment gained through traditional farming practices. For example, everyone made the link between heavy monsoon rainfall and landslide activity, yet when asked specifically what causes landslides and debris flows a supra-natural response was often given. At first this seems paradoxical but further analysis shows how people oscillated between these positions, adopting different stances depending on the context. Villagers' explanations for the Patikuna landslide in Duguna village forty years ago illustrate this oscillation:

> *"I don't know the general cause of landslides but I know what caused the Patikuna landslide. The farmland was affected by monkeys – they were coming down from the forest and eating the crops. The villagers trapped the monkeys and set fire to the trees. All the monkeys were killed and the Gods became angry. That's why the landslide occurred. It happened one year after the monkeys were killed…..Rock falls may occur here again but there won't be anymore landslides. There are trees here now so it's safe. The Gods have forgiven them* [the villagers who set fire to the forest]*."*
> (Female, Sherpa, 60 years, non-literate)

This story was recounted to me by many villagers both young and old. What is interesting is the way supra-natural explanations are interwoven with matter of fact observations of the physical environment. For example, the monkeys cursing the village, the heavy rainfall and the absence of trees binding the soil together. As noted by Johnson *et al.* (1982) in the context of farmers on the edge of the Kathmandu Valley, local people link scientific and supra-natural factors in their explanations of hazard causation. What may appear incongruent explanations to an outside observer make sense to the local people themselves.

Similarly, in a study of mountain hazard perception among the Sherpa community of the Khumbu Himal, Bjonness (1986) concluded that the Sherpas perceive their environment in a dualistic manner. They view mountain hazards as both acts of the Gods and as a consequence of the geophysical environment. When mountain hazards harm the villagers they are deemed to be supra-natural; when they warn people they are deemed natural. No such distinction could be made in the Upper Bhote Koshi Valley. Here, supra-natural responses were often given when there was no obvious physical trigger, for example, if landslides occur outside the monsoon season:

> *"Landslides occur because people sin. The Land God and the Nag* [snakes - form of God] *live in sacred areas. If these areas are made dirty, the Gods leave and trigger a landslide. This is why landslides occur in winter. Landslides triggered by the Gods can occur anytime. We worship the Land God and the Rain God."*
> (Male respondent, Tamang, 54 years, educated to primary level)

7.6 Perception of landslide risk in the Upper Bhote Koshi Valley

Thus far, this chapter has shown that householders in the Upper Bhote Koshi Valley have a good understanding of the nature and causes of landslide hazard. In the following section, I explore local perceptions of landslide risk, that is, the likelihood of a landslide occurring or recurring and the potential magnitude of a future landslide. The three on-road settlements of

Chaku, Larcha and Kodari have all been rebuilt following recent landslide events. Migrant communities now occupy the settlements of Larcha and Kodari without any direct experience of landslide activity in their new roadside location. Off-road, the settlement of Marmin was relocated following a landslide 60 years ago, while the 2006 Chambang landslide occurred nearby. For other settlements, such as Duguna, the risk associated with landslide hazard is arguably less apparent. The local people consider the area to be relatively stable but my geomorphological mapping and satellite imagery analysis suggest the settlement is located on an active earth flow, albeit a site that experiences low rates of movement. This raises a series of questions regarding the risk perception of the exposed population. I was interested to know if the current residents were concerned about the threat of landslide activity in the area, if they believed a landslide or debris flow could recur, and, if so, if the event has the potential to be catastrophic.

7.6.1 Magnitude and frequency

On-road settlements

Respondents were seen to draw on their physical experience of landslide hazard (for example, the damage or loss of farmland, property, infrastructure and death or injury); and less substantive forms of evidence. Examples include, observed or reported impacts of landslides elsewhere; and information relayed through social networks, for example, regarding glacial lakes in Tibet:

> *"There may be more glacial lake bursts – there are many glacial lakes in China. We worry about a big disaster in Nepal. Villagers visit China and we heard about the glacial lakes from them. We can't do anything about the glacial lake outbursts. They are beyond our control."*
> (Female respondent, Kami, 59 years, educated to primary level)

In the roadside settlement of Larcha, residents believe a debris flow will occur again. There was, however, disagreement regarding the potential magnitude of a future event. For some householders, there was a belief that the 'big event' had already happened. As one resident of Larcha explained:

> *"We cannot predict the future. The stream is very small but during the monsoon it becomes bigger. A debris flow may occur* [but] *it won't happen again like it did before when the trees were swept away and there was lots of debris. I'm not worried about that this time. The material has been deposited – there's no more debris to move."*
> (Male respondent, educated to primary level, Sherpa, 24 years)

For others, there was concern that a future debris flow could be equally as big and destructive as last time. A number of people showed awareness, and concern for, the active landslides upstream, which they believe could dam the stream channel again causing a catastrophic debris flow. Some respondents placed a figure on the recurrence interval for a debris flow disaster. However, these figures were found to be based largely on hear-say rather than direct observations of the physical environment. As one Chhetri woman explained:

> *"A debris flow will occur here again. There are cracks at the top of the hill – it's very weak. It could be as big and destructive as last time. They say there's a debris flow every 12 years"*
> (Non-literate female, Chhetri, 34 years)

For the residents of Larcha, the 1996 debris flow was therefore viewed in one of two ways: either as an anomalous event; or as an event that could recur but which is essentially beyond their control. This idea of fatalism or low self-efficacy will be discussed in greater detail in Chapter 8 in the context of risk response.

According to Lindell and Perry (2004), exposure to a particular hazard and the personal consequences, such as death and injuries, property damage and disruption to normal activities, is likely to constitute a significant event for the individual, and one that is likely to be remembered as incontrovertible personal evidence of the hazard's potential impacts. Linked to this are the characteristics of event timing, notably the time since the last event, and the medium to long term frequency of impact; the more recent and/or frequent the hazard, the greater the psychological impact (ibid). Individuals who have experienced damage from a landslide are therefore more likely to define future risk as high. This was not, however, the case in Larcha where the three households who directly experienced the event and survived showed no greater concern for a future high magnitude event, than the new migrant community.

The picture was somewhat different in Kodari where the residents displaced by the 1981 landslide consider the area to be too unsafe to occupy: *"We wouldn't live there again"* said an elderly Kami man whose house and farmland were destroyed by the landslide. But for the new residents, the area seems relatively stable. The householders who did show some concern, believed an event was unlikely to be catastrophic. Residents had a tendency to distance themselves from the problem by saying that landslide risk was greater elsewhere, for example, in Tatopani where debris is frequently remobilised blocking the road and threatening houses, or Liping, where floods are known to occur. In comparison to these areas, householders felt Kodari was a comparatively safe area to occupy as exemplified in the following quotations:

> *"There is a possibility that a landslide will occur. If there's a flood in the Bhote Koshi the river may undercut the slope and cause a landslide. I'm not worried about my house. The Liping side of Kodari is more landslide prone"*
> (Male respondent, Tamang, 28 years, educated to secondary level)

> *"The land between Kodari and Barabise is very vulnerable to landslides. The land is steep. Three to four years ago there was a debris flow in the Liping Khola. A distant relative was killed. We used to live in Liping and moved because of the landslide threat. I think Kodari is safer but when it rains, a landslide may occur here."*
> (Male respondent, Chhetri, 38 years, educated to secondary level)

If a landslide does not recur within five years, in general the area is considered stable and safe enough to return. For example, the Chaku landslide occurred in 2001 and by 2006 the households displaced by the landslide were planning to move back; the rationale being that with no continuing or intermittent slope failures, the land had stabilised. Similarly, in Kodari the land was left for approximately eight years after the landslide approximately 60 years ago, before the slope was considered safe enough for settlement construction. For these households there is a belief that a landslide may occur sometime in the future but for now the area is safe enough to occupy. There is certainly some logic to this. Carson (1985), for example, noted that many Himalayan landscapes experience a period of landsliding followed by long periods of inactivity during which time we see the accumulation of a new weathered mantle in preparation for the next major failure. It could be argued, therefore, that it is more 'risky' to occupy slopes that are yet to fail; perhaps a counterintuitive interpretation of a period of quiescence. Overall, there was a general consensus amongst the roadside respondents that the off-road settlements were safer from landslides, a theme I will return to in Chapter 8.

Off-road settlements

Residents in Listi and Duguna felt their houses were located in relatively stable areas. With the exception of the high frequency, low magnitude failures in Paikosa and Pangsing (Listi), and the occasional rock falls in Patikuna (Duguna), the risk of landslides was considered negligible. With Listi constructed on flat land, this is perhaps unsurprising. But, residents in Duguna were aware that a landslide occurred more than 120 years ago. From my mapping exercise the morphology of the slope is indicative of a slow moving earth flow. This site may represent an example of where movement rates are below the level that are discernable on the ground in the everyday. However, this does not preclude the possibility for future reactivation of this seemingly stable site.

In Marmin, the situation was somewhat different, with the majority of residents displaced and resettled by a landslide approximately 60 years ago. The recent 2006 Chambang landslide was a further reminder of the instability of the area. Since the first landslide in the late 1940s, the area has been unoccupied, with the exception of two households: a landless household forced to settle on marginal land and a household who returned to Old Marmin after a period of quiescence. While a few households have attempted to cultivate their abandoned farmland, for the majority of residents the area is considered too unsafe to occupy.

7.6.2 Socio-cultural factors affecting perceptions of hazard and risk

Seventy-two percent (n = 118) of respondents were non-literate and 18% (n = 30) were educated to primary level. Education did not influence understandings of landslide hazard, except in a minority of cases where the respondent, usually a woman, claimed they did not know, attributing their ignorance to their non-literacy. From conversations with many articulate, non-literate women, I do not believe this was the case. Rather, as discussed in Chapter 5, I suspect the women felt they were unable to give a suitably scientific answer and therefore chose not to answer at all. Similarly, with the exception of the above example, there were no obvious gender differences (n = 72 male respondents; and 93 female respondents); differences across caste and ethnic groups (n = 34 high caste; 25 occupational caste; and 106 hill ethnic respondents); or poverty levels (n = 5 very rich; 42 relatively rich; 71 middle income; 43 relatively poor; and 3 destitute).

Stories of the supra-natural were often recounted by the village elders. However, as the above examples show, they are more than aware of the physical causes with respondents often oscillating between explanations. It is important to note that young people made reference to the Gods too, suggesting supra-natural beliefs were not a reflection of age alone. There was very little difference between Hindu and Buddhist beliefs and explanations (a theme I will return to in Chapter 8). However, a minority of households declared they were not particularly religious and their interview responses reflected this. For these households, their interview responses were based on observations of the physical environment, with no reference to the supra-natural. This was particularly the case for some of the low caste households who, traditionally suppressed by the Hindu caste system, do not consider themselves religious (Shrestha *pers comm.)*.

7.7 Summary

This chapter has investigated local understandings and perceptions of landslide hazard in the Upper Bhote Koshi Valley. The findings suggest that occupants of landslide prone areas have a good understanding of landslide hazard and its associated risk. However, we find that landslides are contextualised in terms of the myriad threats and risks facing people and as a result, are seldom a priority concern. Off-road, households were found to prioritise their subsistence needs; while at the roadside, with these needs met, householders aspire to build bigger houses, to expand their business and to generally enhance their well-being.

Landslides are also contextualised in terms of the rationalities that local people bring to bear. Respondents showed a good understanding of the physical causes and triggering mechanisms. However, supra-natural explanations often emerged in what appeared to be contradictory ways. This supra-natural understanding does not go unquestioned but equally the ideas are not totally dismissed. Landslides deemed beyond the control of a household or community were often attributed to “God’s will”. Overall, age, gender, caste, religion, literacy and poverty level were found to have little bearing on respondents’ understandings and rationalities. Similarly, the link between direct experience and/or the length of time in a particular location, and people’s understandings and interpretation of risk were also blurred.

For an outsider, it can be difficult to comprehend that people willingly settle in areas at risk from catastrophic landslide hazards. However, like Lein (2000), I argue that an increase in landslide risk cannot be understood solely as the result of behaviour under constrained circumstances but can also result from taking an opportunity. As concluded in Chapter 6, landslide risk emerges not just from societal marginalisation but also from situations of relative prosperity. People want to live by the road and the majority have been successful in doing so, despite the coincidence of these areas with high probability of instability. Landslide prone areas or not, my respondents saw little future in the off-road settlements. Building on this discussion, the following chapter explores individual, household and community responses to landslide hazard and risk.

Chapter 8

Household and Community Responses to Landslide Hazard and Risk

"We cannot do anything to stop the landslides. All we can do is look for the early warning signs: we watch the stream to see if it becomes muddy and we check the flow. When it expands we think a landslide may be coming. If there is no water in the stream we worry the stream has become blocked which could cause a debris flow. All we can do is escape to the top of the hill."

(Female respondent, Tamang, 55 years, non-literate)

8.1 Introduction

The previous chapter demonstrated that occupants of landslide prone areas have a good understanding of landslide hazard and its associated risk. Whilst both off-road and on-road households prioritise everyday concerns, they demonstrate clear, lived experience of the geophysical hazard. The aim of this chapter is to explore local level responses to landslide risk in the Upper Bhote Koshi Valley; that is, the extent to which people modify their actions to adapt to the unstable geophysical environment in which they live.

Both the psychometric and constructivist approaches to the epistemology of risk have recognised that people's attitudes towards risk partly reflect their feelings of power, or lack thereof, in relation to the source of risk (Jasanoff 1998). The Tamang woman quoted above is aware of the risk of debris flow hazard in Larcha but feels powerless to stop such a landslide from occurring. She is therefore vigilant and responsive to the physical cues she has come to recognise as warning signs of debris flow activity. This was a common response from residents in the Upper Bhote Koshi Valley:

> *"Small failures can be managed usually through everyday agricultural practices where damaged terraces are maintained and repaired. But large landslides are deemed beyond their control. People do not seem to worry about high magnitude events. They are vigilant to changes in the physical environment and response-led."*
> (Research Diary, Upper Bhote Koshi Valley, October 2006)

This chapter draws on the risk perception and response interviews and oral histories conducted in both the on-road (Chaku, Larcha and Kodari) and off-road (Marmin, Listi and Duguna) settlements. I begin by exploring the agency and capacity of households and communities to respond to landslide risk. This includes the mitigation and management of the landslide hazard and resilience building at the local level, and the socio-cultural factors that influence these responses. Finally, the chapter will consider how local people view the existing institutional arrangements for landslide risk management. This chapter will therefore address the following key questions:

1. How do people respond, both immediately and in the long term, to landslide hazard and risk?
2. What socio-cultural factors influence these responses?
3. How do local people view the existing institutional arrangements for landslide risk management?

8.2 Responding to everyday risks

Responses to risk have been found to be closely tied to people's perceptions of risk (Bickerstaff 2004). It is therefore unsurprising that the everyday risks faced by individuals, households and communities take precedence over comparatively infrequent geological hazards (see Section 7.4.2). As noted by one respondent:

> *"If I have extra money I would rather put a tin roof on my house than build gabion boxes to protect the terraces. But I never have any extra money so I'm not in a position to make that choice"*
> (Male respondent, Sherpa, 60 years, non-literate)

At the community level, local community groups including the Women's and Mothers' Groups have focused on sanitation projects, goat rearing programmes and the construction of school buildings (see Section 7.4.1). As explained by a community member in Chaku, the community groups focus on meeting the immediate needs of the community as a whole. As landslide mitigation is not a top priority, villagers rely on reactive intervention in the form of relief:

> *"Community group projects reflect the needs of the people at the particular time. For example, Chaku needed a sanitation awareness programme. Landslides are response-led whereby victims have access to the emergency fund if needed."*
> (Male respondent, Sherpa, 30 years, educated to primary level)

Similarly, the VDC development budgets allocated via the District Development Committee (DDC) has been used to fund a range of development activities and programmes at VDC level, most notably the construction of roads, school buildings, health posts and empowerment programmes for marginalised groups including women, the disabled and low caste groups (Table 8.1). Just under half (46%) of the development funds allocated have been used to fund road construction, with five different rural road projects funded in the 2008/9 fiscal year across the four case study VDCs. While the development budget is being used to fund the

Table 8.1 Development activities in the case study VDCs of Marmin, Phulpingkutti, Listikot and Tatopani in the 2008/9 fiscal year

VDC	*Description of development activity*	*Amount spent (NRs)*	*Amount spent (GBP)*
Marmin	Health post grant	7,000	58
	Maintenance of the Infant Care Centre	8,485	71
	Development grant - Dhaneshwari School	77,500	646
	Chaku-Marmin-Chandaku rural road	424,520	3538
	Foot trial – ward no. 4	30,000	250
	Foot trail – ward no. 5	6,000	50
	Disabled persons empowerment programme	55,000	458
	Dalit empowerment programme	15,000	125
	Education grant	7,000	58
	Tashidhele Children Centre	30,000	250
	VDC profile	24,033	200
	Village Education Committee Grant	19,000	158
	Janajati empowerment programme	25,000	208
Phulpingkutti	Hindi-Narayanthan road construction	7,000	58
	Building construction for a higher secondary school	200,000	1667
	Building construction – Durga public health building	200,000	1667
	Electricity – Kalai settlement	55,000	458
	Temple construction	400,000	3333
	Shree Mahakali Devi building construction	70,000	583
	New roof and toilet at Gorakhnath Primary School	75,000	625
	Shree Golepa-Sephu Road	300,000	2500
	Drinking water supply – Okherkot village	500,000	4167
	Drinking water supply – Sunkhani village	15,000	125
	Bridge maintenance	15,000	125
Listikot	Disable persons welfare programme	2,400	20
	Sub-Health Post improvement programme	100,000	833
	Damlang-Listi-Bhairab Kunda Rural Road	772,990	6442
	Gabion box construction – Kandung Gadh	4,000	33
	Water supply – Anthali	5,000	42
	Building maintenance – Panchakanya School	22,420	187
	Building maintenance – Chhangsing School	15,000	125
	Dharapani mule trail	20,000	167
Tatopani	Dugunagadi rural road	680,000	5667
	Water supply – Dupte gumbe	45,500	379
	Seti Devi Primary School building	42,500	354
	Tatopani Lower Secondary School building	255,000	2125
	Landslide control – Eco Resort, Kodari	25,500	213
	Saraswati temple construction	42,500	354
	Padma Sambhaw Gumba construction	85,000	708

Source: District Development Committee, Chautara, Sindhupalchok District, June 2009.

construction of gabion boxes to protect the terraces in Listikot VDC and slope stabilisation works in Kodari, landslides are, once again, not a priority concern. Landslide mitigation activities account for just 0.6% of the development budget for the 2008/9 fiscal year. It is useful to note how the VDC budget is allocated. Following the 1999 Local Decentralisation Act, local level government became responsible for development planning and implementation at the local level providing a space for local people to express their needs. The budget allocations set out in Table 8.1 are broadly in line with the community vulnerabilities and needs discussed in Section 7.4.1.

As these examples from the household, community and VDC levels demonstrate, landslides are not a priority concern. Nevertheless, local households are aware of landslide risk. The following section explores the factors they identified at interview affecting their ability to respond to this hazard.

8.3 Factors affecting the capacity of individuals and households to respond to landslide hazard and risk

In general, residents articulated a lack of control over the physical environment in which they live. There was a pervasive sense of being powerless to take effective action to manage a hazard as ubiquitous as landslides and debris flows. Participants showed little concern for what Bush *et al.* (2002) term 'intangible, distant happenings' (p. 130), that is, events that seem distant in time and space. They therefore described their response to landslide hazard as largely re-active and response-led. In the absence of early warning systems, physical cues including sights and sounds are the only source of advanced information about a landslide or debris flow hazard. Often, people don't act until the physical cues suggest the hazard is certain, severe and immediate, at which point they engage in the most expedient actions: inform family members and evacuate, helping others if possible. There are, however, no formal evacuation plans and respondents seemed slightly unsure as to where they would go if a landslide did occur, although *"uphill"* was often mentioned. At the roadside, respondents frequently cited the hill village they migrated from as a place they would escape to, with the hill villages deemed safer than the valley bottom. This will be discussed further in Section 8.4. Off-road villagers relied on their family or kinship ties both within and outside the village.

This apparent stoical attitude towards landslide risk actually masks a range of risk reducing actions undertaken at the individual, household and community levels. People were seen to act as conscious agents intervening in the world around them. Some of these strategies and measures were concerned with hazard mitigation and management directly including the maintenance and repairing of terraces and the afforestation of landslide affected farmland; while others, including the establishment of community emergency funds, the stockpiling of food and firewood, and the temporary migration of households to 'safer areas' during the monsoon months, were aimed at reducing susceptibility and building resilience. However, three key factors were identified in influencing how people respond to landslide hazard and risk: the magnitude of the landslide event; the time of day the event occurs; and the level of household poverty.

8.3.1 Magnitude of the landslide event

Overall, the scale or spatial extent of a landslide and debris flow hazard was seen to influence people's sense of agency, an 'individual's perception of whether or not they have the ability to bring about change through their behaviour' (Bickerstaff 2004: 833). Both Bjonness (1986) and Pilgrim (1999) discuss this in the context of landslide hazard and risk elsewhere in the Himalaya and make a clear distinction between events about which something can be done (i.e. decisions made and actions taken) and events which are beyond the mitigating capabilities of the individual, household or community, for example large or rapid landslides. Similar distinctions were made by respondents in the Upper Bhote Koshi Valley.

Across the case study settlements, actions have been taken to prevent small slope failures, for example, through the construction of stone walls to protect terraces, afforestation to stabilise slopes or the use of basic drainage systems to remove excess water from the hill-slope. There was certainly extensive tacit knowledge regarding appropriate and effective farming methods for use in the steep, landslide prone terrain, although this was often difficult to elicit. Questions regarding traditional land management practices often yielded the same, common response: *"we've always done it this way"*, suggesting risk avoidance strategies are deeply embedded. As observed by Johnson *et al.* (1982) most hazard control techniques are interwoven in everyday agricultural practice. Similarly, for Jones (1999) in the Uluguru Mountains, Tanzania, the practice of terracing was very much an unconscious action and a social norm, performed routinely rather than consciously practiced. Interviews with farmers in the off-road settlements in the Upper Bhote Koshi Valley provided an insight into local responses to erosion, gullying and landslides:

> *"Some people practice afforestation and plant trees like the Uttis* [a quick growing tree]. *We have planted trees on our farmland to stop it moving. Every year our farmland moves and our terraces are destroyed. Planting trees stops soil erosion and landslides…….If the terraces collapse we rebuild them and protect them with stone walls."* (Female respondent, Chhetri, 31 years, educated to primary level)

However, respondents felt powerless to influence a problem as large as the Chaku landslide or as rapid as the Larcha debris flow. In such contexts, personal action was regarded as futile:

> *"Stone walls help protect the terraces from small failures but if the landslide is big then walls do not work. When landslides occur, they occur. They are beyond our control. All we can do is help our family and neighbours."*
> (Female respondent, Tamang, 70 years, non-literate)

These expressions of powerlessness are not, I argue, fatalistic or passive but rather pragmatic responses to the physical environment in which people live. Bandura (1977) makes a clear distinction between fatalism and low self-efficacy. Fatalism is a generalised belief about all of an individual's activities, whereas self-efficacy refers to a belief that is specific to an individual's achievement on a given task. The communities in the Upper Bhote Koshi Valley have low self-efficacy towards the mitigation of large-scale landslide and debris flow hazards. In this context accepting the hazard as beyond their control can be viewed as a coping a strategy.

8.3.2 Temporal occurrence of landslides

In addition to the magnitude of the event, respondents made a clear distinction between landslides occurring during the day and events occurring at night. During the day, householders feel they can monitor the physical environment and respond, but if the hazard occurs at night there is little they can do. They are unable to look for warning signs or escape if a landslide occurs. This is exemplified in the following quotations:

> *"If the landslide occurs at night we just try to survive. If it occurs during the day we move to a safe place."*
> (Female respondent, Tamang, 22 years non-literate)

> *"Rains are welcome during the day but not at night. We worry about flooding and landslides. There's no possibility of saving lives if it happens at night."*
> (Male respondent, Sherpa, 65 years, educated to primary level)

8.3.3 Poverty

As discussed in Chapter 6, landslide prone areas in the Upper Bhote Koshi Valley are occupied by relatively rich and relatively poor households of high caste, occupational caste and hill tribe ethnicity. Based upon an exposure assessment alone, the impact of landslide hazard is potentially universal and unspecific. In part, these findings challenge the work on 'environmental justice' (Cutter 1995) which tends to associate high risk areas with poor, disenfranchised communities. However, we do not see an equal sharing of risk burdens between exposed households and to understand this we must also consider the inequities in coping capacity and resilience.

It is widely accepted that poor people's economic standing limits their ability to mitigate the debilitating consequences of hazards (Watts 1983). For example, the relatively poor, occupational caste household renting a room in the basement of a three storey house in the landslide prone area of Chaku is less able to mitigate than their wealthy neighbours who run two successful businesses and own a second house in Kathmandu. The relatively poor household is there through limited or constrained choice, cheap rent and access to day wage labour. The relatively rich household is there through choice, with Chaku being a prime location to run a business in trade. The relatively poor household prays to the Gods and hopes to escape should a landslide occur; while their neighbours have constructed a retaining wall to protect their house and migrate to their second house in Kathmandu during the monsoon months. This example illustrates how household poverty level can be seen to influence risk response.

Having highlighted the factors that affect the capacity of individuals to respond to landslide hazard, the following sections highlight responses to landslide risk demonstrated at the household (Section 8.4) and community (Section 8.5) levels. Section 8.6 then goes on to discuss spiritual or supra-natural responses that also take place.

8.4 Household responses to landslide risk

In addition to the risk reducing actions outlined above, including the construction of stone walls and small scale afforestation designed to mitigate the loss of agricultural land, I was interested to explore the actions taken by villagers to reduce the vulnerability of the household itself. In the on-road settlements of Chaku and Larcha, some householders reduce their exposure to landslide hazard during the monsoon months through temporary migration. However, no such actions were observed in the roadside settlement of Kodari where villagers continue with their day to day business activities. This, at least in part, reflects household perceptions of landslide risk (see Section 7.6.1). Although aware a landslide may recur in Kodari, residents believe it is unlikely to be catastrophic and as long as the road remains open and border trade continues, they remain at the roadside. Concerns over landslide reactivation appear greater in Chaku and Larcha offering an explanation for the temporary migration patterns observed.

A number of householders reported that during periods of prolonged or heavy rain they leave their house and stay with relatives and friends in a safer area. In some instances people close down their businesses between June and September. This was seen to reflect both reduced trade during the monsoon months and general concern over landslide activity. Examples include a middle income Tamang family who run a small hotel adjacent to Chaku bridge at the bottom of Chaku landslide and a relatively rich household who run a herbal business and whose house was damaged by the 2001 Chaku landslide. As noted by one respondent:

> *"There is a limit as to what can be done at the individual and household level. We've built a protective wall in front of our house and we migrate to our second house in Kathmandu during the monsoon months which is safer."*
> (Male respondent of Sherpa ethnicity, educated to primary level, 30 years)

There was also recognition that the off-road settlements are safer areas to occupy during the monsoon months as the landslide hazard is less acute in the hills than the valley bottom. A number of households therefore return to their hill village during the monsoon. For some, this was a direct risk-reducing measure:

> *"During the monsoon season we move to the top of the hill. We have a small house there* [in Phelam]. *Our house in Larcha is more at risk from landslides than our house in Phelam. The house was damaged by the debris flow. The debris swept though the house trapping us all. Three years ago we built the house in Phelam and we've shifted to our house there every year. From there we watch the river and land at the top of the hill."*
> (Female respondent, Tamang, 55 years, non-literate)
>
> *"During the monsoon months we move back to Duguna. Larcha is more landslide prone than Duguna. Duguna is a safer place to be during the monsoon. We have done this every year for the last 15 years - even before the debris flow disaster occurred. We look for signs of landslide activity and pass this information on to other villagers".*
> (Female respondent, Chhetri, 34 years, non-literate)

For others, it served a dual purpose. For one household in Larcha who were attending their farmland in the hill village of Duguna when the 1996 debris flow occurred, agricultural priorities provided coincidental risk reducing benefits. Understanding the 'everyday' therefore offers interesting insights into who is exposed to a particular hazard and why. Furthermore, it is clear that it is not always possible to separate risk avoidance strategies from everyday actions with quite different priorities.

8.5 Community responses to landslide risk

Respondents recognised the importance of social networks, that is '*the relationships between people that facilitate cooperation and coordination amongst members*' (Mazzucato and Niemaijer 2002: 193). In response to the inability of the government to serve their needs, poor people have often formed their own kind of local government to manage certain resources and policies (Wade 1987). Participants placed emphasis on helping each other – on working together as a community and sharing their knowledge. This may include helping elderly members of the village community to evacuate their home or clearing the highway following a landslide event. The case study communities of Chaku, Listi and Duguna have successfully mobilised their capacities through the creation of community groups and societies such as the Women's and Mothers' Groups.

The Women's Groups of Chaku, Listi and Duguna have also established Emergency Funds in their respective villages. The funds were initiated by the Women's Groups themselves, independently of the local government and NGOs, and follow a similar model in each village. Each household within the village pays NRs 20 (approximately 17 pence) into the fund per month. Villagers can borrow money from the fund at 2% interest per month and must repay the loan within six months. Money is borrowed to cover general household expenses, medical costs, or to repair or rebuild houses damaged by fire or landslides. Such groups are viewed as a powerful community asset with the residents of the roadside settlement of Larcha (currently without a women's group or village club) planning to establish a community organisation of its own:

> *"We are planning to set up a community group in Larcha such as a women's group or a club. Such community organisations are important. They can be used to raise funds and can help people."*
> (Male respondent, Sherpa, 42 years, educated to primary level)

However, the attitudes and motivations of community members were seen to vary between settlements. With the exception of Chaku (the oldest and most established of the three roadside villages), the roadside settlements lacked the community cohesion and unity observed off-road in the villages of Marmin, Duguna and Listi. A number of research participants from Kodari, in particular, commented on the absence of a sense of community. From my own experience I was surprised to find that residents of Kodari did not know basic details about their neighbours, for example their caste or ethnicity and the number of members comprising the household. This perhaps reflects the transient nature of the roadside population. The current residents of Kodari have lived there for only a few months to a few years and with economic reasons driving their roadside migration, they are primarily concerned with establishing their roadside businesses and engaging in trade.

8.6 Supra-natural responses to landslide risk

In addition to the physical and social responses identified above, a number of supra-natural responses to landslide risks were also identified. For the majority of informants, the will of the Gods was considered greater than any human agent. Daily prayers are said and rituals undertaken for protection. The presence of household shrines, village temples and stupas are symbols of this daily religious activity. Both the on-road and off-road communities participate in collective worship during the month of May before the monsoon rains begin. The Lamas and Shamans are invited by the villagers to conduct the Bhumi Puja ceremony (Fig. 8.1) to worship both the Buddha and the Hindu Gods to bring the "*the right about of rain for a good harvest*".

Figure 8.1 A Bhumi Puja Festival in Duguna (May 2007). The village Lama organises the ceremony. Male villagers make offerings in the form of eggs and wheat mash to both the Hindu Gods and the Buddha, and chickens are sacrificed for a good harvest.

As discussed in Chapter 7, respondents were found to oscillate between supra-natural and scientific explanations for landslide activity in the Upper Bhote Koshi Valley. Landslide hazards are believed to be common to all steep, mountain environments and for these hazards universal actions can be taken: stone walls can be constructed; and drainage systems and bioengineering can be implemented. But, landslides may also be context specific triggered by the Gods in response to a particular act, for example the killing of monkeys in Duguna, stealing the head from a statue of the village deity in Narayanthan, or the desecration of land in Chaku. In these contexts, religious responses are necessary to appease the Gods deemed responsible. Shamans and Lamas are uniquely qualified to deal with problems particular to locales and local communities. They chase off the evil spirits and negotiate with the deities who are known to reside in particular locations. This offers an explanation for supra-natural risk reducing measures undertaken by certain households and communities in the Upper Bhote Koshi Valley.

With few respondents having 'blind faith' (see Chapter 7), households and communities relied on both religious and non-religious responses. Parallels can be made here with the findings of Pigg (1996) and her work on modern medicine and shamans in rural Nepal. Religious and spiritual beliefs neither go unquestioned, nor are they totally dismissed, even if someone considers themselves to be a modern rather than a credulous believer. As a result, there is often a dual response to landslide risk in the Upper Bhote Koshi Valley. This is illustrated in the following quotations where emphasis is placed on worship and prayer, afforestation and engineering:

> *"The community should work together and build check-dams. We also need to make the Gods happy. We should invite the priests to Chaku to worship the Gods and make them happy. We did this in 2002 in Phulpingkutti Chaku and there have been no landslides since."*
> (Male respondent, Newar, 86 years, educated to primary level)
>
> *"As a community we pray to the Hindu Goddess Kali* [the Goddess of death and destruction] *and the Buddha to bring the monsoon rain on time. We gather in May and June if the rains don't come…. We could plant trees on public land. We could take small trees from the dense forest and replant in areas that are vulnerable to landsliding."*
> (Female, Tamang, 52 years, non-literate)

This 'dual understanding' (cf. Bjonness 1986) is depicted in Figure 8.2. Adapted from the earlier work of Bjonness (1986), this figure illustrates the links between the supra-natural and scientific approach to landslide hazard and risk management. The process of hazard perception and response is certainly not as linear as this diagram suggests. Villagers seek explanations for events by consulting the Lamas but they also draw on their practical knowledge of the physical environment. For example, in Kodari elders want to invite *"one of the big Lamas from Tibet"* to scatter the sacred soil to protect the land from failure. Yet at the same time they are canvassing the VDC for the construction of a retaining wall to protect the toe of the slope from incision by the Bhote Koshi River.

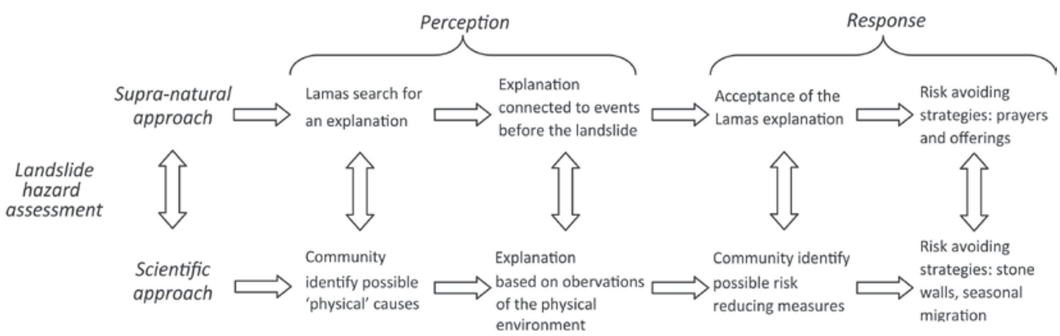


Figure 8.2 A schematic representation of the supra-natural and scientific responses to landslide and debris flow risk in the Upper Bhote Koshi Valley. Adapted from: Bjonness (1986).

8.7 Livelihood transitions during times of crisis

While disaster events undermine livelihoods, they can also influence livelihood trajectories by presenting new opportunities (Rigg 2007). This can be illustrated through two case studies from the Upper Bhote Koshi Valley.

With the exception of one or two households, the people living in Larcha now are all relatives of the victims of the debris flow disaster who have claimed family land. This example illustrates the social reworking of space following a disaster event. For example, before the debris flow in Larcha, Nima Dolma (29 years) lived with her parents in Duguna. For Nima, who is disabled, village life was particularly hard. Unable to work the farmland, there were few opportunities for her in the village. Nima's aunt and uncle were killed in the Larcha debris flow and her parents inherited the land and then passed the land to their daughter. She moved to Larcha in 1997 and runs a small hotel/shop. Her business is doing well and she is happy living by the road. As this case study illustrates, whilst the debris flow was a tragedy for some, the disaster presents new livelihoods for others.

The Kodari landslide resulted in the loss of farmland for the eight households displaced by the event. The land was subsequently abandoned for eighteen years with those affected resettled by the government onto adjacent public land. While the landslide resulted in an initial loss for the displaced households, as their land was no longer suitable for agriculture, it also provided an alternative livelihood opportunity. Approximately one third of the land was sold to a Dutch company which has constructed a hotel at the roadside and an eco lodge on the hillside; while the displaced households have constructed houses to let on the remaining land. They now generate their income through rent and from formal employment associated with border trade providing an alternative livelihood opportunity for them and the migrant households who are renting the houses in Kodari. This case study illustrates the reworking of social and economic space (cf Rigg 2007) that can occur following a disaster event. The displaced family consider the area to be too unsafe for them to occupy but are willing to build houses to let. As one young woman in Kodari explained:

> *'15 ropanis of farmland were abandoned following the landslide. We've built two houses on the land – one is being let and the other is just finished. We can't farm the land so this is a way of getting income from it……If there is no landslide within five years we will get our investment back in rent. We wouldn't live there again – we would worry'*
> (Female, Kami, 23 years, Kodari).

It could be argued that the households originally displaced by the Kodari landslide may, in livelihoods terms, have benefited from the landslide. With their property and farmland destroyed they started again and with a heightened potential for accumulation.

8.8 Local perspectives on institutional arrangements for landslide risk management

Participants were interviewed to determine their views of the institutional arrangements in place to help them respond to landslide risk. The majority of participants complained that this support was insufficient and identified two key sources of assistance that they required: financial compensation (Section 8.8.1) and technological solutions (Section 8.8.2).

8.8.1 Compensation

The issue of compensation was the main area of contention. While the government provides compensation to the victims of landslide disasters, the amount given is negligible. The VDC is responsible for compensating villagers for small damages and losses but if a large landslide occurs, the VDC informs the DDC office. Participants explained how they must travel to the District Headquarters in Chautara (a six hour return bus journey) to register their loss and to collect their compensation. However, the cost and length of the journey (which invariably results in the loss of one to two days of waged labour) means that often people do not register their losses and do not receive the compensation they are entitled to. Respondents were also concerned about their low levels of literacy and their inability to complete the necessary administrative forms required by the District Officials. This is illustrated in the following quotations:

> *"The government provides some compensation for farmland but it's a nominal amount. We received NRs 2,500 for 7 ropanis* [0.23 ha] *of farmland. You often spend more getting to the District Headquarters to claim."*
> (Male respondent, Tamang, 38 years, educated to secondary level)

> *"The Government are doing nothing. Compensation is needed! We didn't receive any compensation when our house was destroyed here in Chaku and we've had to abandon the land. We informed the government but they could not help."*
> (Male respondent, Sherpa, 17 years, educated to secondary level)

More generally, non-literate participants felt they were unable to discuss their issues or grievances with the government. They were unsure about the bureaucratic system and did not feel they would be listened to by the officials. Respondents felt detached from Central government who to them appeared only concerned with the Kathmandu Valley. In some instances, respondents made comparisons between the Nepali and Indian Governments, a reflection of the time spent in India as migrant workers. These respondents viewed the Indian Government as comparatively pro-active and efficient.

> *"Since the debris flow disaster the government has not done anything. If this was India, the government would be more proactive. The government should construct*

> *check dams across the stream to make the settlement safer."* (Male respondent, Tamang, 57 years, non-literate)

8.8.2 Landslide mitigation and management: the desire for a 'technical fix'

Long and van der Ploeg (1994) note that knowledge is based on both indigenous experience and introduced techniques, as outside technology and ideas are absorbed and reworked. It is perhaps unsurprising therefore that research participants felt that engineering was the key to managing large scale slope failures deemed beyond their control. Frequently cited examples include the construction of retaining walls and check-dams which have been used at various points along the highway to protect problematic sections of road. Local people feel that such engineering solutions should be used to stabilise slopes and protect against debris flows across the six case study settlements and they believe this to be responsibility of the government. As two respondents explain:

> *"The government provides emergency assistance but before events they do nothing. The government should undertake preventative measures like check dams and supporting walls."*
> (Female respondent, Sherpa, 22 years, educated to primary level)

> *"The government are not doing anything. The road was damaged by a landslide three years ago because the land is subsiding due to the river. The government have not done anything. They should construct a retaining wall for protection from the Bhote Koshi."*
> (Male respondent, Sherpa, 32 years, educated to primary level)

It is important to recognise, however, that many of these perceived technological solutions would, in practice, be both impractical and financially unviable.

8.9 Summary

Figure 8.3 illustrates the thresholds of response to landslide hazard discussed in this chapter. It shows that high frequency, low magnitude events (which result in regular, small-scale terrace collapse) are responded to at a household level. Landslides are mitigated through the construction of stone walls and small-scale afforestation; and vulnerability reduced through temporary migration. However, when damage exceeds the coping capacity of individual households, they turn to relatives, extended family and the local community. At this level, community based responses (emergency funds and support through Women's Groups) strengthen coping capacity, and in areas without access to this social capital, coping capacity is reduced. However, for events that inflict medium-level damage to property and farmland, local VDC compensation is sought. At this level compensation is reasonably effective given a very limited budget. However, at the DDC level where claims for severe loss of livelihood or loss of life are taken, pragmatic factors (distance, expense and loss of earnings from travel) prevent local people accessing compensation. For high magnitude, low frequency events assistance is guided by national level policy. This policy tends to be top-down and response-led. The following chapter discusses the factors that inform and shape these policies and explores different actors' perspectives of landslide risk management in Nepal.

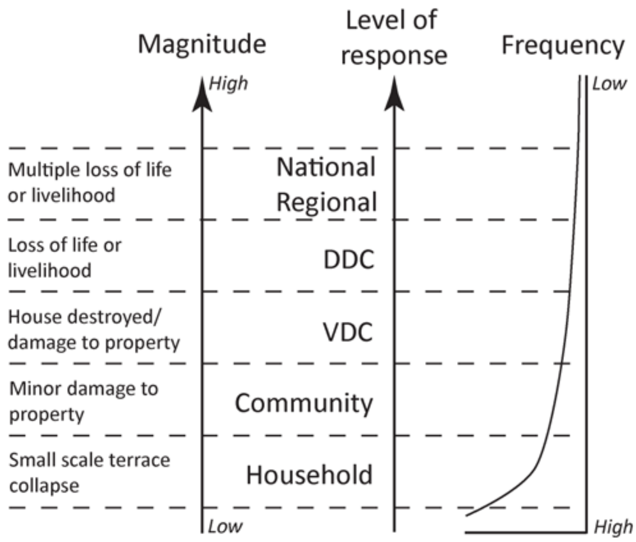


Figure 8.3 Thresholds of response to landslide hazard (Based on household interview data, October 2006 and May 2007)

Chapter 9

Institutional and Expert Understandings of Landslide Risk in Rural Nepal

"Everywhere I work I find local professionals who know and respect the pragmatic contributions of geography to development. They are hardly aware of the extreme minority positions that either attribute all reality and causal power to discourse or to inexorable natural forces."
(Wisner 2009[1])

9.1 Introduction

Thus far, this thesis has taken a largely bottom-up approach to investigate who occupies landslide prone areas and why; and how landslide risks are perceived and responded to by 'at risk' rural communities. The emphasis of my research now shifts as I begin to explore institutional approaches to landslide risk management. Beginning with a historical overview of the risk discourse in Nepal, this chapter investigates current landslide policy and how this has been informed and shaped. In particular, I examine how certain discourses around risk have become privileged and institutionalised; to what extent current policy works in practice and whether current policy adequately reflects the lived experience. In so doing, this chapter will explore the knowledge held by actors; and the way this knowledge is framed and articulated with a view to challenging a series of 'binaries' found within the hazard and risk literatures. These binaries may be categorised as theoretical, for example, constructivist versus realist debates; epistemological, for example, scientific expertise as opposed to lay knowledge; and methodological, for example, reductionist versus holistic approaches. In line with the many critiques of such binary distinctions (see, for example, Murdoch and Clark 1994; Forsyth 2003), I demonstrate that each 'side' cannot be quite so simply drawn with frequent common ground. In moving the debate on, I argue that people have a broadly shared understanding of landsliding as a geophysical process across actor/stakeholder groups. The differences instead arise between actors' individual framings of landslide risk, which reflect different stakeholder priorities and motives. The chapter will therefore address the following questions:

1. How is landslide policy informed and shaped in Nepal? How has this changed over time?

[1] The Ben Wisner reference is drawn from an e-mail post to the AAG Cultural Ecology Specialty Group e-mail list on the 12 June 2009, archived at http://lists.psu.edu/archives/aag-cesg-l.html

2. How is landslide risk situated in the current planning context?
3. How divergent are different actors' views of landslide risk in Nepal?
4. To what extent have intellectual debates within the field of hazard and risk research impacted upon stakeholder thinking?

The chapter draws on interviews, focus groups and a workshop undertaken with stakeholders working within the field of road construction, landslide mitigation and management, and disaster risk reduction (DRR). These include representatives from government ministries and departments, technical specialists (geologists and engineers), livelihood and development specialists, and employees of multi- and bi-lateral agencies and non-governmental organisations (NGOs). A series of national policy documents including the Tenth Development Plan (National Planning Commission 2002), the Interim Plan (National Planning Commission 2007) and the National Strategy for Disaster Risk Management (UNDP Nepal 2008) are also critiqued along with other associated grey literature.

9.2 The emergence of hazard and risk discourse in Nepal

Over the last few decades, risk has become a major area of academic inquiry, particularly within the field of disaster research. I begin, therefore, by investigating the historical roots of the risk discourse within Nepal. This, I argue, can be traced back to the environmental crisis narratives that began to emerge around the same time as the foreign aid programme in the early 1950s (Table 9.1). Bankoff (2004) contends that developing countries were first represented as 'primitive' societies needing to be rescued by 'aid', whilst more recently they are cast as 'vulnerable' and in need of 'relief'. As the following discussion demonstrates, discourses around hazard, risk and development are constituted, contested and reproduced (cf Nightingale 2003) through national and international institutions including the Government of Nepal; bilateral and multilateral development agencies including the UK Department for International Development (DFID) and the United Nations; and the local communities themselves.

9.2.1 Theory of Himalayan Environmental Degradation

Historically, as discussed in Chapter 6, the Nepalese state exhibited little concern for the environment, reflecting its highly extractive practices and isolation from ideas about 'scientific management' (Guthman 1997). It was not until the emergence of the Theory of Himalayan Environmental Degradation (THED) in the 1970s that serious attention was given to

Table 9.1 Development initiatives and environmental policy in Nepal (adapted from Guthman (1997))

	Modernisation Era (1951-1973)	*Basic Needs Era (1974-1984)*	*Neo-Liberal Era (1985 - present)*
International Level	• Emphasis placed on growth-led development including agricultural intensification and commercial forestry • 1971 – UN Conference on Human Environment	• Scaling back of aid • Multi-lateral assistance increased • Emphasis placed on basic needs • Development institutions began to show an interest in large-scale environmental issues	• Emergence of the neo-liberal aid regime • Emergence of anti-developmentalism rebuked classic understanding of environmental degradation • Promotion of bottom-up approaches to community resource management
Hindu Kush Himalayan Region	• 1960s - regional concerns regarding deforestation, erosion and flooding • Early 1970s – Himalayan-Ganges link	• UNESCO established highland-lowland interactive systems project • Establishment of Mountain Research and Development journal • 1974 – Emergence of the Theory of Himalayan Environmental Degradation	• Early 1980s – detailed research to quantify the extent of environmental degradation was undertaken • Himalayan Theory of Environmental Degradation challenged
National Level	• Early 1950s - aid contingent on the establishment of a national planning process • 1952 – first published observations of environmental degradation in Nepal • 1956 – First Five Year Plan placed emphasis on preserving forest resources • 1957 – Forest Nationalisation Act • 1962 – UN report linking peasant behaviours and environmental degradation in Nepal • 1965 - Third Five Year Plan paid no attention to environmental issues • 1971 - Established Task Force on Land Use and Erosion Control	• 1975 – Fifth Five Year Plan emphasised agricultural growth and rural development along with the need to control deforestation to prevent soil erosion and landslides • 1980 – Six Five Year Plan emphasised the need for conservation measures • Political decentralisation, participation and collective action • 1976/80 - decentralisation of resource control e.g. community forests reflecting the failure of forestry to be a viable industry	• Failure of the Basic Needs strategy especially in terms of agricultural productivity • Renewed interest in infrastructural development • 1987 – World Bank Structural Adjustment Programme • Emphasis placed on enhancing local control

environmental issues. THED asserted that anthropogenic or accelerated erosion was a serious and widespread problem in the steep-sloped and fragile natural environments of the Hindu Kush-Himalaya region (Messerschmidt 1987; Blaikie and Muldavin 2004). Population growth, extensive cultivation onto steeper slopes and unsustainable use of the forest for fuel wood and fodder was believed to have caused accelerated erosion, contributing to the sedimentation of river beds, and leading to increasingly severe flooding downstream (Ives 2004). THED was based largely on work in the natural sciences but its explanations in terms of human causation drew upon notions of 'backwardness', technological incompetence and neo-Malthusianism (Blaikie and Muldavin 2004). As noted by Guthman (1997) and Campbell (2003) among others, THED became the dominant environmental narrative in the international arena for more than two decades. Hajer (1995) describes such narratives as devices through which actors are positioned, and specific ideas of 'blame', 'responsibility', 'urgency' and 'responsible behaviour' are attributed. THED privileged the role of science and expert knowledge of the degradation processes, thus legitimising top-down policy and enforced conservation measures (Table 9.1).

However, an increasing stream of evidence started to question this position in the 1980s (Thompson and Warburton 1985; Ives and Messerli 1989; Ives 2004) and as result THED was subsequently, in large part, rejected. The broad conclusion was that the anthropogenic causes of erosion had been overplayed and they were relatively minor compared with natural causes (a high natural rate of erosion due to rapid orogenic uplift leading to mass wasting) (ibid). As summarised by Blaikie and Muldavin (2004), THED had over generalised and overdramatized the sense of environmental crisis. There was also growing recognition of the mitigation activities by farmers who were seen to contribute positively to environmental conservation rather than being the cause of the problems (see, for example, Johnson *et al.* 1982).

9.2.2 The disasters paradigm

Following the reframing of THED in the 1980s, the 1990s saw the emergence of a new environmental narrative in Nepal, this time concerning the apparent increasing occurrence of 'natural' disasters. Driven by the international community, the 1990s saw the establishment of the International Decade of Natural Disaster Reduction (IDNDR), argued principally to be a brainchild of the scientific community (Varley 1994). At this time, technocratic knowledge dominated the debate with hazards commonly treated as specialised problems reserved for the advanced research of scientists and engineers (Hewitt 1983a; Hewitt 1997). The IDNDR was, in many respects, envisaged as an event where scientific knowledge would simply be 'put into practice' to prevent disasters (Christoplos 2003). Debate remains on the success of this approach; a situation where our judgement is ultimately inhibited by the lag time for legacy effects of policy decisions which play out over subsequent years or even decades. An apparent continuing increase in the number of disasters is mirrored by numerous largely successful examples with ‘hard designed’ and engineered solutions to large-scale potential slope instabilities associated with highway construction.

These ideas have long been challenged by anthropologists (see, for example, Oliver-Smith 1979; Torry 1979a; 1979b) and geographers (O'Keefe *et al.* 1976; Wadell 1977; Wisner *et al.* 1977) but little impact was made beyond the academy (see Chapter 3 for a more detailed discussion). It did, however, lead to a growing body of literature between the 1980s and 1990s examining the links between disasters and development (see, for example, Blaikie *et al.* 1994; Varley 1994) with research drawing on a political ecology approach (Watts 1987; Pelling 1999). As summarised by Mitchell (2006), this work created a more robust set of theoretical and practical arguments to support a constructionist approach to disasters.

However, it was not until the mid-term review of the IDNDR in Yokohama in 1994 that disasters were formally recognised as being *‘embedded in the political structures, economic systems and social orders of the societies in which they take place’* (Bankoff 2004: 35). The successor to the IDNDR, the International Strategy for Disaster Reduction (UN-ISDR), emerged following growing recognition that the human and economic impact of disasters had not been reduced (UN-ISDR 2005) and the science underpinning the technocratic model of disaster management was inadequate in the face of the complexities and uncertainties associated with physical and social systems. This resulted in the emergence of the Hyogo Framework for Action (HFA), ‘Building the Resilience of Nations and Communities to Disasters’, following the World Conference on Disaster Reduction (WCDR) in January 2005. The HFA is centred upon the concept of disaster risk reduction (DRR). While there has been continued debate regarding the definition of DRR (Twigg and Steiner 2002; Tearfund 2003), the UN-ISDR has published the following working definition:

> *The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impact of hazards within the broad context of sustainable development’* (UN-ISDR 2004: 17).

The HFA sets out a number of goals and priorities. These are to:

- ensure that DRR is a national and a local priority with a strong institutional basis for implementation;
- identify, assess and monitor disaster risks and enhance early warning;

- use knowledge, innovation and education to build a culture of safety and resilience at all levels;
- reduce the underlying risk factors;
- strengthen disaster preparedness for effective response at all levels

(UN-ISDR 2005).

Nepal was one of the 168 countries to sign up to the Hyogo Framework for Action. However, a number of implementation challenges have been identified at government level and among international NGOs and donor organisations in Nepal. These include a lack of political will; the challenge of mainstreaming into existing policy and practice; and an inability to agree on a series of benchmarks and indicators for measuring progress (see, for example, Twigg *et al.* 2000). However, despite these challenges, DRR is beginning to move up the policy agenda at the national level and is becoming more prominent in the operational and funding guidelines of the bilateral and multilateral donors and NGOs. A major catalyst to this has been the growing concern about anthropogenic climate change and its impact on the Himalayan Region. In particular, the uncertainty associated with climate change and the potential increase in disaster occurrence is a key focus (Alam and Murray 2005; Alam and Regmi 2005). For example, the potential impact of climate change on monsoon intensity, the main trigger of landslide activity in Nepal, is currently unknown (see Section 2.4.5). Table 9.2 maps the links between the key academic frameworks, international initiatives and the policy context in Nepal.

Table 9.2 Mapping the links between the academic frameworks, international initiatives and the policy context in Nepal

Academic framework	*Description*	*International initiatives*	*Nepali context*
Neo-Malthusian (1970s)	Population growth is regarded as the cause of degradation as the carrying capacity of the land is exceeded	Theory of Himalayan Degradation (THED) Emphasis placed on scientific knowledge	Top-down policy and enforced conservation measures overseen by international donor agencies
Paternalist/ technocratic (1970s)	The land user is environmentally unaware, ignorant and mismanaging the environment	As above	As above
Engineering paradigm (1990s)	Hazards viewed as specialised problems reserved for the advanced research of scientists and engineers	International Decade of Natural Disaster Reduction (IDNDR) Emphasis placed on scientific knowledge and technology transfer	National Action Plan for Disaster Risk Management
Development/ structural paradigm (roots in Neo-Marxist Dependency theory) (2000s)	Vulnerability	International Strategy for Disaster Reduction (UN-ISDR) and Hyogo Framework for Action (HFA)	Drafting of a National Strategy for Disaster Risk Management

9.2.3 The rhetoric of development and the role of 'local' and 'outside' knowledge

In the decades since the Second World War the rhetoric of development has shifted through several stages, from economic growth, growth with equity, basic needs, participatory development, and, now, sustainable development (Potter 1999). The post-war development project in Nepal can be grouped into four aid regimes: modernisation, basic needs, neoliberalism and alternative development, with each regime reinforced by a set of dominant ideas regarding the goals and strategies of development and thus the role of local and outside knowledge. Figure 9.1 provides a simplified schematic representation of the changing role of local and outside knowledge with time. It should be emphasised that this is a didactic device with the aim of teasing out the complexity of the relationship between local and outside knowledge. Beginning with the pre-modern era, the four aid regimes (A - D) are outlined briefly below inasmuch as they have implications for the framing of, and responses to, environmental hazard and risk in Nepal.

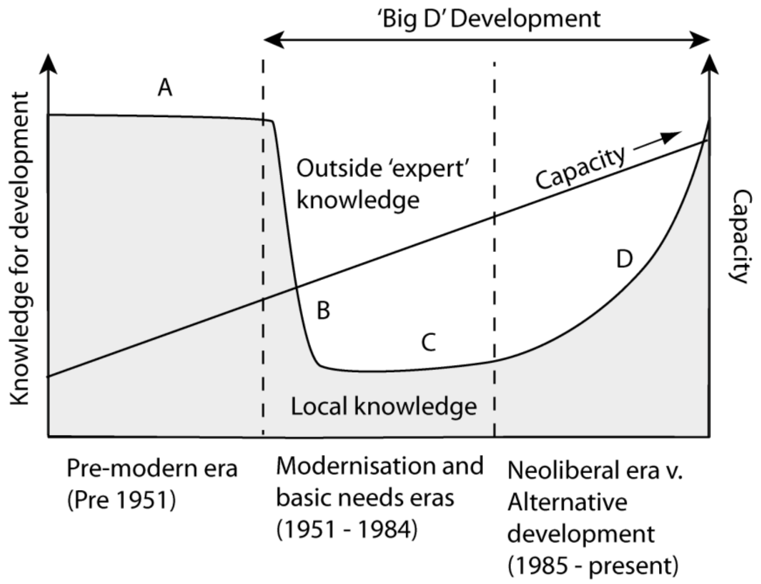


Figure 9.1 The role of local and outside scientific knowledge for Development. Local knowledge unintentionally dominated during the pre-modern era (A). Outside scientific knowledge began to dominate during the post-Second World War Development project (coined 'big D' Development by Hart (2001)) which saw outside intervention in the 'third world' (B and C)). The role of outside knowledge has since been challenged following the emergence of 'alternative development' in the late 1980s resulting in a shift in development policy towards participation, empowerment and capacity building at the local level (D).

Pre-modern era (pre-1951)

Prior to 1951 the state was centralised under Rana rule. As discussed in Chapter 6, the Ranas were largely concerned with maintenance of law and order and the collection of taxes from land with a limited focus on economic growth and development (Blaikie *et al.* 2000). Given the degree of difficulty in transportation there were long lags in communication between the districts and central authorities in Kathmandu. Districts were therefore largely self-governing with limited, if any, input from the Rana Regime. Even as a quasi-colony of the British, Nepal remained largely autonomous. Local knowledge therefore unintentionally dominated in the pre-modern era (Fig. 9.1 A). Risks were prioritised and managed internally. However, it is important to note that local knowledge was not a static, pristine and untainted knowledge system. Indeed, as noted by Campbell (2004), among others, local knowledge has never been isolated. As discussed in Chapter 6, trade routes, political conquests and military and scientific expeditions have long contributed to the exchange of knowledge.

Modernisation era (1951-1973)

The 1950s saw the arrival of international aid in Nepal as part of what Hart (2001) terms 'big D' Development; the post-war Development project in the third world. Modernisation theory placed emphasis on economic growth and industrialization through the diffusion of formal, scientific knowledge from the North to the Global South (Briggs 2008). Development at this time was a fundamentally technical issue, driven by the dominant science discourses of Europe and North America (ibid). Outside scientists were allowed into Nepal, which led to some of the first published observations of environmental degradation. International power relations ensured that western beliefs about ecological degradation prevailed over the Nepalese state to promote 'scientific' management of natural resources in the hills (Nightingale 2003). Under the guidance of 'outside scientists' emphasis was placed on the need to preserve forest resources which resulted in the Forest Nationalisation Act in 1957 and a task force was established on land use and erosion control in 1971. Officials were trained by international donor agencies, many of whom obtained degrees in the US and Europe helping here, I suggest, to further entrench western ideas. The modernisation era was therefore associated with a rapid decline in the value and role of local knowledge in the sphere of policy, environmental management and decision-making (Fig. 9.1 B). However, the limited agility and efficacy of policy implementation on the ground may concurrently have sustained local knowledge (see, for example, Bienen *et al.* 1990).

Basic needs era (1974-1984)

In the early 1970s, Nepal became a major target for foreign assistance, having been identified as one of twenty-five Least Developed Countries (Blaikie *et al.* 2001). Multilateral assistance grew from 1% to 46% of total assistance between 1974/5 to 1980/1 (Guthman 1997). Disillusioned by the failure of the modernisation approach to development, the basic needs strategy emerged. Under this, development was redefined as a broad-based, people-oriented or endogenous process (Elliot 2008). This was aimed at meeting the requirements of 'the poor' for minimum consumption and essential services, including adequate food, shelter and clothing, drinking water, sanitation, public transport and cultural facilities (Blaikie *et al.* 2000). Driven largely by international aid agencies, the basic needs strategy placed emphasis on democratic participation. In Nepal this comprised District level development planning supervised by the national level 'Back to the Village Campaign'. However, the provision of basic needs was still largely approached with universalistic solutions, with participation incorporated into Nepal's development strategy as a token, rather than a central driving force (ibid). The basic needs era, therefore, remained dominated by outside often pragmatic science-based knowledges (Fig. 9.1 C).

Neo-liberal era (1985 to present)

By the mid-1980s, neo-liberal thought had become the new orthodoxy influencing development policy (Cammack 2002). Such approaches advocate economic liberalisation and a reduction in the role of the government including in the provision of basic services and is, in many ways, regarded as a reformulation of modernisation theory (Kothari and Minogue 2002). Of particular interest for this discussion is that neoliberalism makes a distinction between local and professional knowledge (Nightingale 2005). Rather than technology transfer associated with the modernisation era, under neoliberalism, development programmes aim to facilitate the "diffusion of knowledge" to what are perceived to be backward populations or localities (ibid: 582). Neoliberalism is therefore associated with the professionalization of knowledge (Escobar 1995; 2003; Nightingale 2005). In the context of landslide hazard, this may constitute the professional management of the forest resource or the application of bioengineering for slope stabilisation. For example, as the Local Development Officer (LDO) for Sindhupalchok District explained:

> *"The DDC has learnt bioengineering to stabilise slopes in Jalbire and Jaymire VDC* [two landslide affected VDCs in Sindhupalchok]*…..We discuss the development activities with the villagers – what is good and what is bad. We help them form self-help groups."*
> (LDO, Chautara, Sindhupalchok District, June 2008)

Here, the LDO makes a distinction between local and outside 'professional knowledge' and the need to transfer this knowledge to the villagers for 'Development'.

Decentralisation has also emerged as an important instrument of environment and development policy under neo-liberalism in the last two decades reflecting the (variously partial) failure of externally introduced development initiatives (Agrawal 1995; Agrawal and Gupta 2005). The justification for decentralisation in Nepal has been to increase local participation in planning and the implementation of development strategies, to mobilise local resources for development, and to increase accountability of officials to citizens (Bienen *et al.* 1990). For example, as discussed in Chapter 8, VDCs are now responsible for the allocation of their own development budget, with road construction being a main priority. However, under neoliberalism, decentralisation is guided by outside 'professional' knowledge, as the above quote from the LDO illustrates.

Alternative development

While neoliberalism can be seen to be shaping the current political economy of Nepal through structural adjustment and other economic programmes (Rankin 2004), we have also seen the emergence of alternative development. Under this approach, greater attention is given to 'human agency', with local actors being viewed as knowledgeable and capable strategizing agents rather than passive recipients of development (Chambers 1983). This resulted in a shift in development policy towards participation, empowerment and capacity building (Shepherd 1998). Development programmes are no longer solely concerned with the 'ends' i.e. forest conservation or infrastructure development, but also the 'means'. Such programmes focus on livelihoods and integrated development. For example, many donor and government supported road construction projects have been reformulated as 'roads plus' projects, reflecting a recognition that development is predicated on the fulfilment of a range of basic needs not only road access. This includes access to health care, education and opportunities for income generation. Such projects are also conducted in a participatory and empowering way targeting the poorest of the poor and minority groups, in particular, the low/occupational castes and the hill ethnic. Examples include the DfID funded Rural Access Programme (RAP) and the Department of Local Infrastructure and Agricultural Roads (DoLIDAR) rural road construction project. In both examples, road building groups comprising the poorest families in the community are established. These families receive an income during the road construction phase and support to invest their savings into new incoming generating activities for the post-construction period. The RAP project has also set up a local initiatives fund to provide access to technical advice and services for initiating income generating opportunities (Weatherell *pers comm*.).

In parallel with this there has been a growing recognition of the value of local knowledge, and the development of methods and practises to achieve this. This is viewed as the latest and best strategy against poverty and underdevelopment (Atte 1992; Scoones and Thompson 1994; Blaikie *et al.* 1997) and disaster risk specifically (Dekens 2007; UN-ISDR 2008). This is a response to the long held assumption that a community's own methods of coping with risk are too primitive, too inefficient or too ineffective to deal with the situation (Bankoff 2004). A number of international agencies have been deploying indigenous knowledge in their development strategies (Briggs 2008). The World Bank (1998), for example, argues that there is a need 'not only to bring global knowledge to the developing countries, but also to learn about indigenous knowledge from these countries, paying particular attention to the knowledge base of the poor' (p. i).

A key tool in achieving this aim is provided via participatory research, a further example of a discourse which has permeated academic and practitioner thinking. Since the 1970s, emphasis has been placed on culturally appropriate development and indigenous knowledge with 'social feasibility' studies being incorporated into the planning process (Escobar 1991). Multilateral and bilateral donors and NGOs continue to place emphasis on participation. While technical specialists often seem to recognise the role of local knowledge in environmental problem solving (the use of local knowledge to assist bioengineers in selecting altitude specific plants for slope stabilisation purposes or in the identification of former landslides when choosing a road alignment, for example), they were keen to share their own, often negative, experiences of participatory engagement. Some members of the focus group were clearly frustrated by the participatory process, which often causes an apparent rejection of outside technical expertise in favour of local knowledge, sometimes inappropriately so.

One example from one of the focus group participants illustrates the shift towards a participatory approach. An engineering geomorphologist had been asked by the Department of Roads to advise on a suitable alignment for a rural road. He stated in the focus group that his advice was ignored and the road, instead, was constructed on a river bed in accordance with the demands of the local people, who considered the area to be safe from flood hazard despite the concerns of the technical specialist. A year later, a high magnitude flood occurred, destroying the road and settlement. In this context, local knowledge was deemed admissible in a field which, arguably, is heavily laden with technical questions. Technical specialists feel their knowledge is undervalued as illustrated in the following quotation:

> *"I dislike this* [participation] *and maybe it's my biasness…but all the donors are for that* [participation] *and I am against that……The fundamental basic knowledge from the disciplines* [geology, hydrology etc.] *is gone forever. If you think geology is rubbish ok fine but the point is you have to prove geology is rubbish and hydrology is for the gutter. Scientists have been working for 300 years developing the discipline and they* [local people] *deny everything. So it is called peoples' participation. This is the peoples' participation. But without the knowledge how can you guide people the way, the right track? You have to have the participation of people that is very nice but first you have to train them, teach them what has to be done and not be done."*
> (An engineering geologist, focus group participant, Kathmandu, June 2008)

9.2.4 Summary

To summarise, the risk and vulnerability discourse in Nepal can be linked to the emergence of 'big D' Development. Since the early 1950s we have seen marked shifts in the role of local and outside knowledge. The Modernisation era saw the transfer of formal, scientific expertise resulting in a rapid decline in the role of local knowledge and this continued throughout the Basic Needs era despite a growing emphasis on participation. The rise in local knowledge since the mid 1980s, I argue, reflects the emergence of alternative development, which places greater emphasis on bottom-up approaches and participatory development; and from the mid

1990s, the civil conflict, which, in the absence of local government and development professionals in rural areas, halted the transfer of 'professional' knowledge under the neoliberal model for Development. What impact, then, has this had on landslide risk management in Nepal? This will be explored with a brief overview of landslide policy and practice.

9.3 Landslide risk management in Nepal: policy and practice

In this section I provide an overview of the current legislative and policy framework and the organisational structure of landslide risk management in Nepal. What has become evident from this research is that the nature of the hazard I am dealing with is dispersed, is relatively low frequency, and in all but the most extreme circumstances, is low impact. The implication of this for my research is that evidence of the success or failure of risk management policy and practice only leave a subtle expression on both the social and physical environment. This is in direct contrast to the explicit manifestations of the society-environment interactions in, for example, flood prone Bangladesh (see Cook 2008). Nepal has traditionally adopted a top-down, response-led approach to disasters with a focus on actions that can be taken during or after a disaster has occurred. Little emphasis has been placed on landslide risk management either by identifying and reducing the landslide hazard or by reducing the vulnerability of those 'at risk'. However, more recently disaster risk reduction is being seen as a pre-condition and an integrated aspect of sustainable development (UN-ISDR 2002). Such ideas are beginning to filter down to the national policy level (National Planning Commission 2002; 2007) (see Table 9.2).

9.3.1 Legislative and policy framework

Before legislation was brought in to formalise disaster management, disasters were managed on an ad-hoc basis as and when they occurred. The governance of natural hazards in Nepal began with the ratification of the 1982 Natural Disaster Relief Act which saw the establishment of Central, Regional, District and Local Level Disaster Relief Committees and relief funds under the Ministry of Home Affairs (Ministry of Home Affairs 1982). The Act sets out clear organisational responsibilities which were largely focused on disaster relief and response, but limited consideration was given to disaster mitigation and preparedness.

Since the early 1990s, disaster risk reduction issues have gradually been given more weight, with national policy being informed and shaped by international initiatives such as the International Decade of Natural Disaster Reduction (IDNDR) and multi- and bi-lateral funding institutions that are mainstreaming DRR activities into development projects (DFID 2006). At the national level, devastating floods in Central Nepal triggered by the intense 1993 monsoon was a further catalyst for change (Dahal 1998). In 1996 the Government of Nepal produced the National Action Plan for Disaster Risk Management (Ministry of Home Affairs 1996) in accordance with the IDNDR and this remains the focal framework for natural disaster management to date. The plan addresses disaster preparedness, response, reconstruction, rehabilitation and mitigation, and is supported by the 1999 Local Self Governance Act which promotes the concept of decentralisation and encourages the management of disaster risk primarily at District and VDC level (UNDP Nepal 2008). This approach is in line with current neo-liberal thinking (see section 9.2.4).

The technical specialists in my focus groups voiced criticism of the Government's decentralisation of development activities. While this provides VDCs with the opportunity to prioritise certain development activities according to local needs, such activities often exacerbate pre-existing slope instabilities increasing the vulnerability of hillside villages.

> *"Our mountains are fragile and people living there for thousands of years have been working there in their own way but now they want infrastructure but they are not aware of soil type, rock type and rainfall so they think they can construct a road anywhere they want…*[the] *government is allocating funds to the VDC without any guidelines for road construction or infrastructure development."*
> (An engineering geologist, focus group participant, Kathmandu, June 2008)

A number of strategy plans have also been drafted, including the Tenth Five-year Development Plan (2002-2007) (National Planning Commission 2002) and Interim Plan (National Planning Commission 2007); the National Water Plan 2005 (WECS 2005); and the Water Induced Disaster Management Policy 2006. The key features of each strategy plan are set out in Table 9.3. Despite more than ten years of enforcement of the National Action Plan for Disaster Risk Management, interviews conducted with residents in the Upper Bhote Koshi Valley suggest that progress towards DRR has been slow, halting and patchy. This was affirmed by the interviews I conducted with representatives from Central and Local Government. In Sindhupalchok District, and elsewhere, district level development plans and hazard maps are yet to be prepared; and, as discussed in Chapter 8, the District Disaster Relief Committee (DDRC) remain largely engaged in preparedness and post-disaster activities only. The DDRC, which includes the police, army, local political leaders, the Red Cross, and the Local Development Office, coordinate the relief effort from the District Headquarters and meet annually before the monsoon. Relief materials are stockpiled in the District Headquarters and across the 13 Red Cross outposts across the district.

Table 9.3 Disaster risk management strategy plans

Strategy Plan	*Focus*
Tenth Five-Year Plan (2002-2007)[2]	Emphasis placed on earthquakes and water-induced disasters including flood, drought, landslide, debris flow and GLOF • Strengthening institutional capabilities • Preparation of risk maps for floods, debris flows and glacial lake outburst floods • Establishment of a river control master plan • Establishment of early warning systems in the main watersheds • Awareness raising
Interim Plan (2007-2010)	Emphasis placed on: • Cooperation between the government, non-government and the private sector • Hazard assessments integrated into infrastructure development planning • Awareness raising programmes • Hazard mapping • Improved weather forecasting • Soil erosion, landslides and flood control works
National Water Plan (2002-2027)	Emphasis placed on water-induced disasters • Preparation of risk maps at district level • Establishment of early warning systems across the country • Hazard mitigation – river control and watershed management • Emergency relief materials available in all five development regions
Water Induced Disaster Management Policy (2006)	• Emergency relief • Mitigation of water-induced disasters • Conservation of natural resources • Institutional management and development

Source: National Planning Commission (2002; 2007); Pradhan (2007).

The limited focus on DRR at the District level has been attributed to a lack of financial resources; ineffective institutional mechanisms and inadequate policies; a lack of coordination among the various institutions involved in disaster management; and the continuing political instability which has reduced the capacity of the government, halted field surveys and construction activities in rural areas, and limited participatory engagement (Pradhan 2007). These issues were raised by the Local Development Officer who, during an interview, explained:

> *"The Government has no plan for disaster risk management. Within 12 years our government presence* [has been] *limited because of the People's War. We can now go back in. There was no government access to the rural areas because of the insurgency……….We* [the Local Development Office] *focus on development activities*

[2] The Eleventh Five-Year Plan will supersede the Interim Plan in 2010.

> *like road construction, irrigation and other activities. We have to think about landslides but we have so little money we cannot do anything. We should also undertake a geological study but we don't have the specialist expertise – no skilled personnel. We should also study the environment but in the DDC we only have a small project."*
> (LDO, Chautara, Sindhupalchok District, June 2008)

These views were congruous with those of the Joint Secretary of the Ministry of Local Development (MoLD) who commented that:

> *"It* [landslide risk reduction policy] *is effective to some extent but it is insufficient because of the resources. Implementation is not sufficient. We say that people directly affected by disaster will be resettled but it takes years and years to find alternative land and to resettle people. The policy is there but it is difficult to implement because of the lack of resources."*
> (Joint Secretary, MoLD, Kathmandu, June 2008)

The Government of Nepal and the Ministry of Home Affairs is now in the process of preparing a National Policy on Disaster Management and a revision of the Natural Disaster Management Act facilitated by the National Centre for Disaster Management (NCDM) and Oxfam (NCDM 2008); and a National Strategy for Disaster Risk Management with the UNDP Nepal (2008) in accordance with the UN-ISDR Hyogo Framework for Action. In line with this the Government of Nepal is planning to form two additional bodies, a National Council for Disaster Management and a National Disaster Management Authority to work in the area of vulnerability reduction and resilience building. The National Council will be responsible for policy formulation while the NDMA will be responsible for implementation, coordination and monitoring.

9.4 Actors in landslide risk management

Having outlined the current policy and legislative framework, I now turn my attention to different actors' views of landslide risk management in Nepal. In addition to the residents interviewed, these actors include the government, multi- and bilateral institutions, technical specialists and NGOs, all of whom are involved in the development, implementation and criticism of policy in Nepal.

9.4.1 Local residents

Local perceptions and responses to landslide hazard and risk are explored in detail in Chapters 6, 7 and 8. By way of summary, my findings highlight local concern with short-term survival over long-term risk reduction; local people react to landslides as and when they occur. Participants noted the absence of the state in landslide management activities highlighting instead the role of local informal institutions such as the Women's and Mothers' Groups that are actively engaged in development and, to some extent, disaster management activities through the establishment of an emergency fund. For the local people themselves, their priorities are livelihood security and wellbeing.

9.4.2 Government institutions

As discussed in Section 9.3.1, a number of government ministries and departments are involved in landslide risk management. The main institutions at policy and coordination level include the National Planning Commission, which formulates periodic and annual plans; and the Ministry of Home Affairs (MoHA), which overseas natural disaster management through its 75 district administration offices. The MoHA is responsible for the formulation of national policies and their implementation; preparedness and mitigation activities; immediate rescue and relief work; data collection and dissemination; and the distribution of disaster relief funds (Pradhan 2007). Additional institutions at the implementation level include the Department of Water Induced Disaster Prevention; Department of Soil Conservation and Watershed Management; Department of Hydrology and Meteorology; Department of Mines and Geology and the Department of Roads (ibid). However, despite a move towards disaster risk reduction (see Section 9.3.1), the traditional top-down, response–led approach to disaster management continues to dominate.

9.4.3 Technical specialists

Technical specialists are involved in both academic research and the provision of information and advice. They therefore bridge two kinds of knowledge as identified by Scott and Shore (1979) - 'knowledge for understanding' and 'knowledge for action'. While academic research focuses primarily on the geophysical hazard (see, for example, Dahal and Hasegawa 2008; Hasegawa *et al.* 2009); consultancy is concerned with landslide risk assessment for example, in the selection of a suitable road alignment or locating a hydropower dam. Much academic research is 'applied' for example, developing techniques for landslide susceptibility mapping (Pantha *et al.* 2008) or predicting slope failure (Dahal *et al.* 2008).

Technical specialists may be affiliated to an academic institution, a private organisation, a government department, or may even act as individuals with no affiliation, with each group viewing landslide hazard from their own institutional perspective. There may also be overlap between stakeholder groups, for example technical specialists working within the Department of Soil Conservation and Watershed Management are working within the government's mandate focusing on developing landslide mitigation measures. Technical specialists affiliated to the Mountain Risk Engineering Unit at Tribhuvan University may be engaged in both independent research and consultancy, for example, undertaking geomorphological assessments for the DfID funded Rural Access Programme.

As discussed in section 9.2.2 and 9.2.3 the hazards field has long been dominated by technical rationality. However, what we see in practice in Nepal is far more nuanced than this binary distinction suggests. Outside actors were found to have a pragmatic understanding of landslide risk reflecting the dynamic geophysical environment and high levels of poverty and underdevelopment characteristic of Nepal. Considering the hazard, technical specialists certainly recognised the limitations of a hazard-oriented approach. While there was a general agreement amongst actors that hazard maps are required with the aim of delineating high-risk areas there was an awareness that vast areas would fall under the category of 'high hazard'. What, then, do we do with such maps when they are created? As a focus group participant explained:

> *"If we produce some accurate mountain hazard maps then I do believe the whole of the mountain area will come under high hazard. There's nowhere to do any development work. The people in Nepal have to live with some risk…and that is the reality."*
> (Geologist, focus group participant, Kathmandu, June 2008)

Similarly, the approach of road construction engineers is perhaps surprising, given their long-term association with the technical rationality.

> *"The only way for rural roads is to acknowledge landslides are going to happen….*[This] *is a very different approach to standard road building where you are building a road for 50 years. It's the same evolution that's taken place in the management of floods - for years and years engineers just built walls but eventually the flood will get it you just don't know which year it will happen so let's not build on flood plains and allow the river to flood and we don't try and stop nature being nature and I think that's a much more realistic approach you can't stop every single landslide. Yes some of them will be caused by the road construction but a lot of them are going to happen anyway…..understanding where landslides might occur and making people aware of the vulnerability of that section is a much more practical approach than trying to avoid all landslides along roads which is just unrealistic."*
> (Infrastructure Advisor, DFID Nepal, Kathmandu, June 2008)

Moreover, in the context of risk, a consideration of vulnerability is widespread. The technical experts recognise that the transfer of outside knowledge, expertise and technology alone is unlikely to reduce landslide risk. This is encapsulated in the following quotations from two focus group participants:

> *"People are migrating to the road for good economic reasons and they're likely to weigh up the economic benefits they get now versus potential risk and there are lots of surveys on peoples' perceptions of risk and how great they are at ignoring them and the only viable way round it is to give them an alternative but that's where the money*

> *comes in – how are you going to get people to move somewhere safer? Awareness raising in the landslide prone areas is a first step"*
> (Geologist, focus group participant, Kathmandu, June 2008)

> *"Unless you give them better opportunities, better livelihoods the people living in high risk areas they won't move even if you educate them and make them aware of the risk. Just making people aware doesn't mean people will move because they don't have an alternative - most of them don't have land elsewhere. People live along the highway because they have weighed up the pros and cons of living in a landslide prone area and have made an active choice, conscious choice to stay there. Some people have no other choice but many do have choice but think it's a risk worth taking."*
> (Hydrologist, focus group participant, Kathmandu, June 2008)

The findings show the technical specialists to be reflexive and aware thus challenging the distinction between technical and cultural rationality.

9.4.4 Multilateral and bilateral development institutions

Multilateral development institutions, such as the UNDP and the World Bank, and bilateral agencies, such as the UK DFID and the SDC, fund and manage a range of development projects in Nepal including road construction and water and sanitation projects. The multilateral institutions in particular are helping to drive policy and practice following the establishment of the Hyogo Framework for Action (UN-ISDR 2004). The UNDP has been instrumental in devising the country's National Strategy for Disaster Risk Management (UNDP Nepal 2008), in line with its focus on prevention. Interest in disaster risk reduction is also growing in bilateral institutions with the mainstreaming of disaster risk reduction into development activities (see, for example, DFID 2006). While the policies and strategies of the bilateral agencies regarding disaster risk reduction are providing a mandate to project planners, the question still remains regarding how rigorously risk is being brought to the fore (Christoplos *et al.* 2001).

9.4.5 Non-governmental organisations

Non-governmental organisations (NGOs) are primarily concerned with humanitarianism; their task being to save lives and address human suffering. DRR has, in the past, been placed low on the agenda as a focus on hypothetical long-term objectives is perceived as conflicting with their ethical commitment to a demonstrable life-saving response; while their humanitarian neutrality demands a distance from the political sphere (Christoplos 2003). That said, there are a number of NGOs now working in the field of disaster risk reduction in Nepal with DRR moving up the policy agenda and becoming more prominent in their operational and funding guidelines. Examples of active international and national NGOs include Action Aid and Practical Action, the National Centre for Disaster Management, the Nepal Landslide Society and the National Society for Earthquake Technology, to name but a few (Table 9.4). As noted by Benson *et al.* (2001) the involvement of NGOs in disaster risk management varies according to internal factors, such as links between relief and development departments, and external factors, such as donor priorities and the contested roles of state and civil society in highlighting and managing risk.

Table 9.4 The role of non-government organisations in DRR activities

INGO/NGO	*DRR activities*
Action Aid Nepal	• Resilience building amongst poor, excluded and vulnerable groups • Coordination of awareness raising programmes in schools and the wider community
Practical Action	• Strengthening existing community level coping strategies • Development of low-cost early warning systems
National Centre for Disaster Management	• Organisation of disaster preparedness workshops • Devising disaster policy and legal frameworks for the government
Nepal Landslide Society	• Assimilating knowledge on landslide mitigation and management through seminars, workshops and an international conference • Advocates the need for landslide hazard mapping
National Society for Earthquake Technology	• Earthquake preparedness and mitigation • Devising DRR policy and legal frameworks for the government

9.4.6 Cooperation and interchange between actors

The interviews and workshop discussion highlighted that there is surprisingly little interchange between actors, and that research, consultancy and development activities are being undertaken in an ad hoc fashion. As one workshop participant highlighted:

> *"The problem of integrating academic knowledge into the implementing agencies is an alien concept for us. The government doesn't normally take input from academia. If they need to know something they will hire consultants. There is not a good link between academic and government circles in trying to use the knowledge in the implementation phase."*
> (Geomorphologist, workshop participant, Kathmandu, June 2008)

9.5 Binaries within the academic literature

A number of binaries or dichotomies exist within the science and technology, development and natural hazards literatures. In the context of my research in Nepal, I found evidence of these binaries but often, and quite commonly, the debate is not as explicitly defined. Here I explore these binaries in the context of my findings which I categorise as philosophical or theoretical, for example, constructivist versus realist debates, or naturalist versus humanist approaches. Beneath these theoretical dichotomies are a series of other, implicit, binaries. These are epistemological, for example, scientific expertise versus lay knowledge; and methodological, for example, reductionist versus holistic approaches. While a number of authors have emphasised the many middle positions which incorporate elements of binaries (see, for example, Forsyth 2003; Rigg 2007), the didactic approach adopted here seeks to set out the main debates and criticisms directed at each approach. My later analysis, however, attempts to disrupt this binary thinking that, in my view, continues to plague dialectics.

Much has been written about the division between scientific and lay knowledge (Beck 1992; Fischer 2000). Murdoch and Clark (1994) trace this back to the enlightenment, which saw the separation of nature from society. Science, by virtue of its rigour and rationality, became the dominant paradigm while knowledge systems lacking in these attributes were categorised as 'backward' or 'primitive' (ibid). Such ideas have emerged within the diverse fields of science and technology and development studies. As summarised by Leach *et al.* (2005), science and technology studies have examined issues of scientific and technological practice and culture, as well as the specific technological products and risks of modern science in 'Northern' settings. Development studies has engaged with similar issues in 'Southern' settings but with a greater emphasis on agriculture and rural issues, on the connections between technology and livelihoods, and on the perspectives emerging from so-called 'indigenous' knowledges in relation to modern expert-knowledge interventions (Scoones and Thompson 1994; Leach and Mearns 1996; Sillitoe 2004). Ideas emerging from both science and technology, and development studies, have raised a series of questions regarding knowledge, practice, agency and expertise. A series of binaries have subsequently emerged, including scientific/traditional, expert/lay, and technical/cultural.

In their work on environmental risk assessment, Plough and Krimsky (1987) contrast the expert's technical rationality with the concept of 'cultural rationality'. 'Technical rationality' is a mindset that puts faith in empirical evidence and the scientific method; it relies on expert judgements in making policy decisions. In contrast, 'cultural rationality' gives equal weight to personal and familiar experiences rather than depersonalised technical calculations. Within the hazards field, status has been afforded to scientific knowledge because of its rigour and rationality, for example, through the empirical techniques of risk assessment (Murdoch and Clark 1994; Fischer 2005). Science, with a common tendency to reduce to a perceived narrow technical definition of risk is amenable to prediction, management and control by expert institutions and public policy (Leach *et al.* 2005). Publics are assumed to be unaware of or to misunderstand risks in these same technical terms, and thus a key challenge for policy is seen as educating publics and communicating risks in rational terms (Leach *et al.* 2005). The scientific discourse is generally assumed to convey the 'facts', while other interpretations are often regarded as mere 'perceptions' (Jones 1996).

This division between 'expert' and 'lay' understandings of hazard and risk emerged in conversations with technical specialists regarding landslide risk management in Kathmandu. On the one hand, during a focus group discussion, geologists and engineers were found to be dismissive of villagers' religious beliefs and their 'fatalistic' attitude:

> *"They believe in god in the rural area and so they say if god is angry it will happen otherwise it will not happen."*
> (Engineer, focus group participant, Kathmandu, June 2008)

Despite a growing recognition of the value of lay knowledge within both academic and practitioner circles, the predominantly high caste Nepali scientists placed emphasis on the need to 'educate' rural people about the risks they face – to transfer their expert, rational knowledge to the non-literate villager. As one participant explained:

> *"..now they are building hotels* [small shops selling food] *in the same place after that disaster – it clearly shows how naïve rural people are."*
> (Engineering geologist, focus group participant, Kathmandu, June 2008)

However, a more in-depth analysis revealed that my findings were more nuanced than these binaries initially suggest. During the focus group discussion, engineers and geologists showed a well-versed understanding of the perspectives, capacities and priorities of rural people. Moving beyond a technical approach, they recognised that there were often underlying and complex reasons as to why people occupy landslide prone areas, with lay peoples' understandings being more sophisticated and complex than they have perhaps been given credit for. Geologists and engineers were undoubtedly recognising people's agency. There was also agreement that based on the likelihood of slope failures, the decision of local people to occupy these areas was largely a rational one and on that basis the expert and lay concurred. This is illustrated in the following quotations:

> *"People live along the highway because they have weighed up the pros and cons of living below a landslide prone area and have made an active choice, conscious choice to stay there. Some people have no other choice but many do have a choice but think it's a risk worth taking."*
> (Hydrologist, focus group, Kathmandu, June 2008)

> *"People think the risk is worth taking because….the facilities, infrastructure in the village is so low….if you quantify it I would have to say that the risk is worth taking. At the roadside where you have better access to hospitals, schools, business, transporting goods, I would start thinking yes there is a risk but is it worth taking and most people would say yes."*
> (Geologist, focus group, Kathmandu, June 2008)

An extensive body of research now challenges the dominant assumptions of scientific knowledge (Wynne 1992). '[S]*cience has been recognised as needing to accept its own cultural boundaries, frames and blinkers that obscure and patronise the intellectual and moral substance of other ways of knowing'* (Leach *et al.* 2005: 9). It has also been argued that public understandings of science are more sophisticated and nuanced than they have been given credit for (see, for example, Slovic 1992; Wynne 1992). Lay people have been acknowledged as having other bodies of knowledge and other ways of knowing – different systems of meaning, saliency and value - which need to be taken into account (Leach *et al.* 2005), and I suggest could be more locally valuable in living with risk. 'Local knowledge' has emerged from the development studies field '[w]*here science is seen as standardised, de-contextualised and universal, local knowledge is strongly rooted in place'* (Murdoch and Clark 1994: 118). In addition, as Chapters 6 and 7 argue, areas of concern for those seemingly 'at risk' may be more multi-dimensional and varied than the scientific viewpoint suggests and the technical specialists involved in landslide risk management acknowledge this.

Similar debates have occurred within the multi-disciplinary field of disaster studies which has been dominated by a hazard-centred paradigm (Hilhorst 2004). Emphasis has been placed on expert scientific knowledge and modern interventions (Escobar 1999), geared towards developing technology for monitoring and predicting geophysical phenomena and 'managing' nature through engineering (Lee and Jones 2004). Such ideas were echoed at the recent UN-ISDR World Landslide Forum where it was noted that:

> '[l]*andslide disaster can be reduced by understanding of mechanism, prediction, hazard assessment, early warning and risk management. In addition, landslides can be prevented from occurring by various measures to remove landslide causes and to stabilise slopes, while it is not possible to prevent most other hazards such as earthquakes, volcanic eruptions, tsunamis and typhoons.'*
> (Sassa 2008: vii)

This approach has been challenged by others - in particular, the structural paradigm which places emphasis on addressing the root causes of vulnerability (Hewitt 1983a). Such approaches recognise the importance of participation and local knowledge. Ideas emanating from the structural approach are starting to permeate international policy-making most notably through the International Strategy for Disaster Risk Reduction (ISDR), which shows signs of a shift to a more midway position between the technical and structural paradigms. As noted by the UN-ISDR

> '*an over-concentration on technical abilities at the expense of the human aspects that compose the economic, social and political dimensions of societies, will provide disappointing results in sustained commitments to risk reduction.'* (UN-ISDR 2004: 9)

A broad awareness of the connections between disasters and development processes by all stakeholder groups suggests that the extensive debate on the nature of vulnerability to disasters that has taken place in the academic field (see, for example, Wisner *et al.* 2004), has permeated into wider thinking.

The underlying reasons for the apparent decline in the dominance of scientific knowledge are concisely summarised by Mitchell (2006: 49), who identifies three interrelated reasons, described below. Each of these is clearly manifest in the context of landslides in my own findings from Nepal:

i) A realisation that scientific and local understandings of risk can be considerably different, and thus uni-directional models of risk communication are unhelpful and potentially damaging.

ii) An increasing appreciation of the sophistication and accuracy with which people understand the intricacies of the environments in which they live.

iii) The growing awareness of uncertainty in complex social-ecological systems, which cannot adequately be addressed by scientific knowledge alone.

Adding to this list, a fourth reason, I suggest may reflect:

iv) the move towards participatory and empowering methods and an ethic of research which privileges, or at least does not denigrate, the local and the traditional.

However, while there is increasing agreement that scientific knowledge is more useful in a multi-disciplinary approach to disaster risk management - as are each of the alternative methods discussed - risk governance in Nepal remains largely centred on technical rationality. This involves the top-down transfer of information about probabilities and magnitudes from expert to lay person, and a requirement to educate people about the risks they face (cf. Mitchell 2006). Although there are pressures, and no doubt a recognition of and desire to adopt more progressive approaches to landslide risk management, the disconnect between policy and practice, the fragmented governmental structure and the relative spectrum of day-to-day concerns faced by the government and experienced by communities, renders these good intentions at best.

9.6 Summary

This chapter has shown that the emergence of hazard and risk discourse in Nepal has always been driven by international agendas, which can be seen to follow academic debates (Table

9.2). We have seen a succession of environmental narratives developing from the Theory of Himalayan Environmental Degradation to the current disaster risk reduction paradigm. With this evolution, vulnerability, livelihoods and alternative development have come to the fore and participation, empowerment and capacity building have become necessary in any policy approach. My findings support this; the importance of participatory methods and the social contexts are clearly demonstrated, for example, in the road construction approaches discussed in my interviews.

Within the current planning context, landslides are one of many hazards for Nepal to address. There is recognition of the need for disaster risk reduction within the policy context but there is a disjuncture between the rhetoric and what is happening on the ground. DRR is currently difficult to implement because i) political instability has complicated the policy development and ratification process and ii) decentralisation of responsibility has taken place without clear guidance leading to poor distribution of resources and expertise.

For the most part, the main actors have a broadly shared understanding of landsliding as a geophysical process but their individual viewpoints reflect their priorities and motives. The division between lay and expert, local and outside knowledge was shown to be somewhat artificial. For example, technical experts argue that their technical expertise is ignored in favour of fashionable participatory approaches, but recognise lay people's decision-making as largely rational. There is clearly an appreciation of other knowledge types between lay and expert actor groups but in terms of coordinated actor response there is a lack of joined up thinking. As noted by Fischer (2000) the challenge is '*how to discursively integrate the two forms of knowledge, rather than rejecting one for the other'* (p. xiii).

Chapter 10

Landscape, Livelihoods and Risk: Towards a Reflexive Approach

"Risk management cannot, of itself, address the underlying causes of poverty. But if approached from the standpoint of resilience, it can help to build those structures that will enable a greater degree of self-help. It is about helping people to help themselves. The mechanisms, resources, capacity do exist."
(O'Brian *et al.* 2006: 76)

10.1 Introduction

This thesis has taken an interdisciplinary approach to investigate the vulnerability of rural communities to landslides in the Nepal Himalaya. Firstly, a bottom-up livelihoods-based approach was adopted to examine who is vulnerable to landslide hazard; why people occupy landslide prone areas; and how 'at risk' rural communities perceive and respond to landslide hazard and risk. In so doing, this thesis has approached the question of landslide vulnerability from the position and perspective of the vulnerable people themselves. Secondly, the research explored how scientists and policy experts view landslide risk management in Nepal and how policy is subsequently informed and shaped.

The starting point for this research was an ongoing study by the International Landslide Centre at Durham University examining the temporal and spatial occurrence of fatal landslide activity in Nepal. Petley *et al.* (2007) observed that whilst landslide activity is strongly controlled by monsoon intensity, in recent years the number of fatalities has increased dramatically over and above what might be expected as a result of the climatic condition alone. A number of explanations have been postulated, including population growth, land use change and the development of transport infrastructure. Of these, the most likely impacts are thought to be related to rural road development. However, to date there is little evidence to support these causes and, indeed, very little research into the nature of landslide vulnerability in the Nepalese context. This research, therefore, set out to examine and, where necessary, challenge a series of assumptions made in the context of landslide vulnerability in Nepal with a view to developing a better understanding of social vulnerability and its underlying causes.

I approached the research largely from a natural science perspective and my epistemological approach was largely positivist. However, over the course of the research my position gradually shifted, often in response to the evidence as it emerged so that I began to take a more realist and sometimes weak constructionist approach. As discussed in Chapter 5, I do not discount the relevance of empirics when it comes to understanding landslides, but have come to realise that 'facts' are slippery and that explanatory frameworks need to be contextually attuned.

This Chapter is divided into three sections. I begin by bringing the research findings from the different chapters together in order to answer the research questions set out in Chapter 1, before discussing the implications of the research findings. I then briefly explore the aspects of the research that could influence policy with a particular focus on landslide risk reduction along road corridors. The final section identifies areas for further research.

10.2 Research synthesis

10.2.1 Methodologies

The research was conducted over four visits to Nepal between April 2006 and June 2008. A range of qualitative, quantitative and participatory methodologies were used to explore the physical and social landscape in the Upper Bhote Koshi Valley. I began with a geomorphological mapping exercise to delimit and define past landslide activity across the six case study settlements. This provided a positivist evidence base used to explore local understandings of, and responses to, landslide hazard and risk. Community profiles and baseline surveys were compiled providing a detailed ethnographic description of the community context within which the research was undertaken. Household surveys and semi-structured interviews examining risk perception and response were administered across 67 on-road and 98 off-road households. In addition, eighteen oral histories were conducted with householders who had been directly affected by landslide activity. The final phase of fieldwork involved a series of ten semi-structured interviews and a focus group discussion with technical specialists and policy makers. This fed into a final research dissemination workshop in Kathmandu.

10.2.2 Summary of research findings

Who is vulnerable to landslide hazard in the Nepal Himalaya?

The initial geomorphological mapping exercise showed the landslide hazard in the Upper Bhote Koshi Valley to be spatially varied. Different types of hazard were mapped including translational and rotational slides, rock falls, active gullies and debris fans. The nature of the landslide hazard was seen to vary on and off-road, in terms of failure magnitude, type and likely future behaviour. The off-road settlements of Marmin, Duguna and Listi were found to be susceptible to large, slow moving failures that destroy property, infrastructure and agricultural assets, usually without human loss. By comparison, the roadside settlements of Chaku, Larcha and Kodari have been constructed at the bottom of steep, unstable slopes and on colluvial and alluvial deposits commonly adjacent to incoming stream channels. Here, the landslide hazard is acute and potentially catastrophic, given the susceptibility of these channels to damming and breaching by relatively small scale upslope landslides as demonstrated by the 1996 Larcha debris flow. Where people choose to locate is therefore a significant control on landslide vulnerability. In choosing their roadside location, a number of factors came into play. These include: availability of land to buy, rent, or illegally occupy; social ties, for example, living near family members or with other households from the same caste/ethnic group; and, for some households, acquiring land by gift.

Surprisingly, perhaps, landslide prone areas in the Upper Bhote Koshi Valley were occupied by high caste, low caste and hill tribe households. These households were both relatively rich and relatively poor, with seemly no correlation between caste/ethnic group and poverty level. These findings challenge some of the commonly held assumptions within the literature that high risk areas are occupied by the most marginalised groups either through poverty-induced forced migration or because their fixed assets and poverty level tie them to a particular location. It is important to note, however, that vulnerability was seen to vary between households within the landslide prone areas. This is a reflection of a household's resilience and coping capacity which, I argue, correlates strongly with poverty level.

Why do people occupy landslide prone areas in Central Nepal?

As discussed in Chapter 2, landslides are a natural process in any active mountain chain such as the Himalaya. To some extent, therefore, the human occupation of landslide prone areas is inevitable reflecting the natural risk associated with a mountain environment. Traditionally, people settled in the high hills along the stable ridge tops away from the landslide prone areas in the valley bottom. However, changing settlement patterns linked to sedentary agriculture, the salt trade and, more recently, the construction of the Arniko Highway has resulted in traditional settlement patterns and their logics being reorganised. In addition, the natural risk associated with the mountain environment has increased through anthropogenic activities such as road construction which can be seen to destabilise slopes.

The landslide prone areas at the roadside were found to be largely occupied by migrant households. While there is some evidence of inter-district and inter-regional migration, 88% of the migrant households are from Sindhupalchok District and VDCs within the Bhote Koshi Valley itself. A detailed analysis of the socio-economic characteristics of the on-road and off-road settlements (Chapter 6), suggest households are largely migrating to take advantage of the economic opportunities associated with the road. The drivers behind this are complex; for some households outmigration is driven by a pressing need for additional support, whilst for others it is a strategy for consolidation or accumulation. Landslide risk can therefore be seen to emerge not just from societal marginalisation but also from situations of relative prosperity as demonstrated by the two case studies in Chapter 6. These findings challenge a number of commonly held assumptions regarding poverty induced forced migration into high risk areas. People in the Upper Bhote Koshi Valley want to live by the road and the majority have been successful in doing so despite the coincidence of these areas with high probability of slope instability.

As discussed in Chapter 7, risks do not map onto each other. In moving to the roadside some risks are increased for example, the risk of landslide activity, while others are reduced. Roadside households have access to a clean and reliable water supply; are able to find non-farm employment and make enough money to meet their subsistence needs; they can send their children to the nearby public school; and have access to the local health post. Landslide prone areas or not, the research participants saw little future in the off-road settlements.

How are landslide hazards perceived and understood by 'at risk' rural communities?

For the majority of householders in this study, landslide risk was a low priority concern and immediate, more tangible needs were seen to dictate perception of risk. Put simply, and of course there are a number of different experiences, in the off-road settlements, households were more concerned with meeting their subsistence needs; while at the roadside, with these needs met, householders aspire to build bigger houses, to expand their business and to generally enhance their well-being. Local people do not prioritise landslides. This is perhaps understandable as on average, landslides cause 81 fatalities per year in Nepal (Petley, Hearn et al. 2007). By comparison, the top five causes of death in Nepal in 2002 (accounting for 72% of the recorded deaths) were infections and parasitic diseases (54,800 deaths), cardiovascular diseases (49,900 deaths), perinatal conditions (24,500 deaths), respiratory infections (24,200 deaths) and cancers (15,5000 deaths) (WHO 2004). 5.8% (13,600) of the recorded deaths were the result of accidental injury including road traffic accidents, falls, fires and drowning while

3.2% (7,500) were the result of intentional injury including self-inflicted injury, violence and war (ibid).

I was interested to know if the frequency of landslides in the Upper Bhote Koshi Valley was representative of the Middle Hills of Nepal. The Upper Bhote Koshi catchment is approximately 300 km^2 (0.5% of the land area of the Middle Hills). An average of 81 fatalities occurred per year in Nepal between 1978 and 2005. Assuming the population is evenly distributed across the hill districts – you would expect to see one landslide related fatality per year in a valley of this size. Over the same time period the estimated death toll from landslides in the Upper Bhote Koshi Valley is 54 people, approximately two deaths per year. Whilst this is a crude calculation, it is the same order of magnitude as what we see in the Bhote Koshi Valley suggesting the catchment to be representative of the Middle Hills of Nepal.

Many of the case study households were found to have a very good understanding of landslide hazard and its associated risk. While respondents did not talk about landslides as geologists or geomorphologists do, they showed a clear understanding of the causes and triggering mechanisms of slope failure. Supra-natural explanations were also given but few households were found to have ‘blind faith’ (cf. Pigg 1996). Supra-natural explanations did not go unquestioned by the households but equally the ideas were not totally dismissed. Building on the current local knowledge debates (Antweilier 2004), it could be argued that knowledge of the physical environment adequately reflects local needs. For the exposed communities, practical knowledge of the physical environment, for example, an awareness of environmental cues is arguably more useful than an abstract geotechnical-based understanding of slope processes. However, it is important to note, that there are limitations to local knowledge reflecting its situatedness in local culture and environment. Local knowledge is gained through, among other factors, lived experience and memory of past events. Exposure to new and unfamiliar hazards, for example, the 1996 Larcha debris flow, where residents did not recognise the early warning signs, is a case in point.

How do people respond to landslide hazard and risk?

Responses were found to be closely tied to people’s perceptions of risk. Landslide mitigation and management were not, therefore, a high priority concern. Responses were seen to reflect the magnitude of a potential slope failure. While small slope failures can be managed through the construction of stone walls and small-scale afforestation, respondents felt powerless to influence a problem as large and ubiquitous as the Chaku landslide or as fast as the Larcha debris flow. In this instance, responses were found to be largely re-active and response-led. My experience in the Upper Bhote Koshi Valley suggests people do not worry about the hazard until the event is certain, severe and immediate and it is only then that landslides take president over other, more pressing needs.

Responses were also seen to reflect the type of failure. Slow moving failures, for example, the Kodari landslide or the Duguna earth flow are liveable hazards. Rock falls are unpredictable, instantaneous events and are treated as such. In some cases where landslides have destroyed an entire settlement, entire villages have been forced to move onto adjacent land. This has been seen in both Marmin and Kodari. It should be noted however, that the occurrence of landslides was also seen to present new livelihood opportunities.

How is landslide policy informed and shaped?

Landslide policy in Nepal has been shaped by international discourse which can be seen to loosely follow academic debates. These ideas are integrated by the multi- and bilateral agencies into development policy and planning. For these agencies, hazard, risk and vulnerability reduction are high on the agenda, particularly given the uncertainty associated with climate change. Nepal has policies regarding landslide risk management and certainly recognises the problem (Chapter 9), however due to the current political instability within the government, there has been no mechanism in place to ratify or implement these policies. Many of the aims set out in the Tenth Development Plan have not been met, for example, a national programme of hazard mapping. Policy can be seen to map onto the significance of the problem, and while there is recognition that natural disasters such as landslides and floods undermine development activities, these are not, currently, priority concerns. Finally, my research has highlighted a disconnect between the central government and the local level. Society is seen to be self-organising, for example the formation of community groups and the establishment of their own emergency fund with limited, if any, guidance from the local or national government.

10.3 Policy recommendations for landslide risk reduction

With many rural communities still isolated, the main objective of the Government's Tenth Development Plan (National Planning Commission 2002a) is to further expand the road network through the construction of national and regional highways and major roads at local level. It is therefore a logical step for future road design to take into account migration and roadside settlements. Possible risk-reducing strategies identified by participants at the research dissemination workshop include:

1. Avoid the hazard

A detailed geomorphological assessment should be undertaken when selecting the initial road alignment to avoid existing landslides and to minimise future hazard. This should be undertaken as part of the compulsory environmental impact assessment (EIA). In addition, following the construction of the road, hazard maps should be prepared to delineate areas of high hazard. These maps should be used to inform migrant households and to discourage the construction of settlements in high risk zones.

2. Discourage roadside migration

Emphasis should be placed on rural service provision to provide off-road communities with access to water, healthcare and schools with the aim of discouraging roadside migration. Alternatively, feeder roads could be constructed to provide access to the road whilst reducing the need to live directly by it. But, who should take responsibility for this and fund the construction of additional feeder roads? The Department of Local Infrastructure Development and Agriculture Roads (DoLIDAR) is piloting a similar project with the aim of discouraging outmigration from rural areas.

3. Planning for roadside settlements

When designing roads government and donor agencies should plan for the establishment of roadside settlements. This may influence the choice of alignment in the first instance. The road corridor should be zoned to identify the high risk areas to be avoided and the low risk areas suitable for human occupancy. It is recognised that it is difficult, if not impossible, to stop encroachment even into high risk areas. With this in mind, communities should be given alternative livelihoods opportunities in safer areas to encourage them to live away from the high risk zones.

4. Large-scale education campaign

My research has demonstrated that exposed communities have, in general, a high level of knowledge regarding landslide hazard: they know the slopes at risk and have a good understanding of the causal and triggering mechanisms of slope failure. Awareness raising programmes are still considered necessary to ensure people are aware of the warning signs indicative of landslide and debris flow hazards, particularly for migrant households who may be exposed to new and unfamiliar hazards. This should be part of a standard curriculum rather than waiting until a disaster occurs. Warning signs, such as those used in Hong Kong (Geotechnical Engineering Office 2009), would serve as a reminder of the inherent instability of an area and the need to evacuate during periods of prolonged or heavy rainfall.

5. Slope monitoring and the establishment of early warning systems

Despite the high frequency of landslides in Nepal, instrumental monitoring of critical slopes is virtually non-existent, reflecting the reactive rather than proactive focus in (limited) resource allocation. Slopes that are monitored and engineered are normally those threatening strategic roads for example, the Krishna Bhir landslide affecting the Prithvi highway running south of Kathmandu. Such slopes have been stabilised by combining structural and bioengineering methods usually at high cost.

6. Preparedness, planning and capacity building at the local level

Landslides cannot be viably engineered out of a landscape as dynamic as the Middle Hills of Nepal. Building resilience in hazard-prone communities is therefore a top priority. It is essential that the local government and the communities themselves receive financial support and the transfer of knowledge and expertise to achieve this. Local informal institutions such as village clubs and women's/mothers' groups should be strengthened as such groups will enhance the capacity of the community to respond to a hazard. Similar to the case study settlements in the Upper Bhote Koshi Valley, insurance or emergency funds should be established within the local community to help share the loss/burden of disasters. Evacuation plans should also be coordinated at the local level. The local informal institutions may be best placed to coordinate this with assistance from the local government. The efficacy of all these efforts could be optimised through the appropriate involvement of *outside 'experts'*.

It is essential, however, that such approaches should recognise alternative framings of risk (that of the local people themselves) and respond adaptively and reflexively to these to ensure interventions enhance, rather than undermine, livelihoods.

10.4 Areas for future research

A number of areas for future research have been identified. These are structured around four key themes as set out below.

10.4.1 From hazard mapping to early warning

With resettlement opportunities being limited in a mountain environment of high hazard, alternative risk reducing measures are required that can deliver improvements on the ground (Curtis 2004). The current strategy plans (National Planning Commission 2002; National Planning Commission 2007) place emphasis on the need to prepare hazard and risk maps for the hill and mountain districts of Nepal. Such conventional top-down risk reduction initiatives typically rely on the availability of aggregate data sets including generalised slope angle and geology/soil type, usually within a GIS framework in order to delineate broad zones of landslide susceptibility usually in qualitative terms. Low-resolution effectively qualitative landslide hazard maps are problematic as they are likely to classify all areas as some form of high hazard as a function of the extreme slope angles which, from a landslide management perspective, is far from helpful. In such a dynamic environment published maps are by definition out-dated, and often overlook the extreme seasonal variations in ground conditions. In line with this, it is important to remember that mapping is purely a technique and not a solution to the problem. As noted by Olsen and Nilson (1982) there is always a need for serious consideration of what sort of scientific information is most useful.

Rather than preparing overly generalised hazard maps or detailed geomorphological maps, a more rapid rural appraisal/landslide assessment is required at the local level to identify areas of imminent and potentially catastrophic slope failure. Having identified such areas there is the potential to introduce early warning systems, which could include low- rather than high-technology solutions making them appropriate for resource poor, rural areas such as the Upper Bhote Koshi Valley. Such approaches offer a potentially realistic way of reducing the impact of landslide hazards. As my research has shown, people understand and rely on environmental cues but there is no formal early warning system or evacuation plan at community level in response to these. A number of low cost, 'low technology' early warning systems are being developed and have been piloted elsewhere, yet their long-term success and wide scale application remains to be seen. These include:

- The use of rain gauges to monitor rainfall and to alert communities when landslide triggering thresholds are reached (Catane, Zarco et al. 2008).

- The use of extension-meters to monitor tension cracks. This system uses a simple wire to measure vertical and lateral movement and rotational/translational sliding. The wire is connected to a siren to alert the community if significant movement is detected (Karnawati et al. 2008)
- The use of a simple wire strung across an active gully or stream channel which, when disturbed by moving debris, activates a siren alerting the community. Such systems have been piloted in Indonesia (Legono, Pamudji et al. 2008).

Further research is therefore needed to develop these early warning systems and to ensure they are practically applicable. For such systems to be effective, community involvement is paramount as local people will be needed to manage the systems, trust and respond their results.

10.4.2 Re-theorizing risk, vulnerability and resilience

The findings from my research in rural Nepal have highlighted the need to re-theorize risk, vulnerability and resilience. Traditionally, within disaster risk management, emphasis has been placed on vulnerability rather than resilience or capacity. Little consideration has been given to the agency of 'at risk' households and communities. My research has highlighted the capacity of societies to cope with environmental risk and the incongruity between local and outside framings of risk. The work of Gough *et al.* (2007) on well-being is useful here and has considerable potential for better understanding vulnerability and resilience at the local level.

10.4.3 Combining local and outside scientific knowledge for landslide risk reduction

While there is growing recognition of the importance and value of local knowledge for disaster preparedness, there are concerns that indigenous knowledge alone is not enough, particularly given the uncertainties associated with climate change. Similarly, and as my research has shown, the shift towards participatory approaches has received criticism from members of the scientific community who feel their expertise is often ignored in favour of fashionable participatory approaches that satisfy an awareness of community needs, but often not engineering integrity. Opening dialogue between outside scientists and 'at risk' communities and expounding the risks associated with occupying hazard prone areas presents people with the knowledge to make informed choices regarding their own lives, or where choices are limited, to raise awareness for preparedness and planning and empowering people to demand government action for disaster risk management. While the need for such collaborative approaches is well recognised (see, for example, Pelling 2003), moving from theoretical constructions of integration to their application presents the biggest challenge.

Collins and Jones (*per comm.*) at Northumbria University have undertaken a study investigating community based approaches to disaster risk reduction in rural Nepal and have piloted the establishment of risk and resilience committees at the village level. Such groups build on existing informal institutions such as the women's groups and village clubs in the Upper Bhote Koshi Valley but with a specific focus on DRR activities. Establishing an active research network which builds upon local community groups and involves scientists and practitioners would be as obvious extension to this.

10.4.4 Dealing with complexity and uncertainty

It can be argued that too little consideration has been given to the occurrence and subsequent impact scenarios of a high-magnitude, low-frequency event, of magnitude similar to the 2005 South Asian earthquake, or the 2008 Sichuan earthquake. Such events are, in many respects, imponderable. Informed dialogue is needed on what level of natural hazard impact is economically, operationally and organisationally appropriate to plan for, and what form such planning should take (Alexander 2007). While on the one hand it makes no sense to tie up resources for events of very high consequence but very low probability, in recent years there has been a growing realisation in the emergency planning community that it is not sufficient merely to plan for events with high recurrence intervals (Sarewitz and Pielke 2001). High magnitude events need to be planned for from an emergency response perspective. This poses a challenging paradox with the scientific focus upon the extreme, rather than the everyday. The uncertainty of climate change and monsoon intensity as discussed in Chapter 2 is a further area for consideration. Improvements in landslide recording are necessary to understand how climate change is impacting upon landslide hazard.

10.5 Summary

Through a detailed interdisciplinary study in rural Nepal, this thesis has examined social vulnerability to landslide hazard. My findings have challenged a number of assumptions made in the context of landslide vulnerability. In particular, the study has highlighted the changing patterns of risk and vulnerability associated with road construction and the occupation of landslide prone areas. My research highlights the benefits of interdisciplinary working. Such approaches avoid singular views of what 'the problem' and hence 'the solution' might be. Focusing on the physical hazard alone does not explain why people occupy landslide prone areas or the factors giving rise to their vulnerability. Similarly, a social science based approach may negate the landslide hazard altogether and thus fail to consider the potential for a future high magnitude event.

Adams, J. (1995). *Risk*. London: UCL Press.

Adams, W. M. and C. C. Megaw (1997). Researchers and the rural poor: asking questions in the Third World. *Journal of Geography in Higher Education* **21**(2): 215-229.

Adhikari, D. P. and S. Koshimizu (2005). Debris flow disaster at Larcha, Upper Bhote Koshi Valley, Central Nepal. *The Island Arc* **14**: 410-423.

Agrawal, A. (1995). Dismantling the divide between indigenous and scientific knowledge. *Development and Change* **26**: 413-139.

Agrawal, A. and K. Gupta (2005). Decentralisation and participation: the governance of common pool resources in Nepal's Terai. *World Development* **33**(7): 1101-1114.

Alam, M. and L. A. Murray (2005). Facing up to climate change in South Asia. *Gatekeeper Series no. 118*. London: International Institute for Environment and Development.

Alam, M. and B. R. Regmi (2005). Adverse Impacts of Climate Change on Development in Nepal: Integrating Adaptation into Policies and Activities. *Capacity Strengthening in the Least Developed Countries (LDCs) for Adaptation to Climate Change (CLACC)*. Bangladesh: Bangladesh Centre for Advanced Studies.

Alexander, D. (2007). Making Research on Geological Hazards Relevant to Stakeholder Needs. *Quaternary International* **171-172**: 186-192.

Alexander, D. E. (1989). Urban landslides. *Progress in Physical Geography* **13**: 157-191.

Alexander, D. E. (2005). Vulnerability to landslides. *Landslide Hazard and Risk*. T. Glade, M. Anderson and M. Crozier. Chichester, UK: Wiley: 175-198.

Anderson, M. and P. Woodrow (1989). *Rising from the Ashes: Development Strategies in Times of Disaster*. London: Westview Press.

Anderson, M. B. (2000). Vulnerability to disaster and sustainable development: a general framework for assessing vulnerability. *Storms*. J. R. Pielke and S. R. Pielke. London: Routledge: 11-25.

Antweilier, C. (2004). Local knowledge theory and methods: an urban model from Indonesia. *Investigating Local Knowledge. New Directions, New Approaches.* A. Bicker, P. Sillitoe and J. Pottier. Aldershot: Ashgate Publishing Ltd.

Ashley, C. and D. Carney (1999). Sustainable Livelihoods: Lessons from Early Experiences. London: Department for International Development (DfID).

Atte, O. D. (1992). Indigenous local knowledge as a key to local level development: possibilities, constraints and planning issues. *Studies in Technology and Social Change No. 20*. Ames: Technology and Social Change Programme, Iowa State University.

Aysan, Y. F. (1993). Vulnerability assessment. *Natural Disasters: Protecting Vulnerable Communities*. P. A. Merriman and C. W. A. Browitt. London: Thomas Telford: 1-14.

Baird, A., P. O'Keefe, A. Westgate and B. Wisner (1975). *Towards an Explanation of Disaster Proneness*. Bradford: Disaster Research Unit, University of Bradford.

Bandura, A. (1977). *Social Learning Theory*. Englewood Cliffs, New Jersey: Prentice Hall.

Bankoff, G. (2003). *Cultures of Disaster. Society and Natural Hazard in the Philippines*. London: Routledge-Curzon.

Bankoff, G. (2004). The historical geography of disaster: 'Vulnerability' and 'local knowledge' in western discourse. *Mapping Vulnerability. Disasters, Development and People*. G. Bankoff, G. Frerks and D. Hilhorst. London: Earthscan: 25-36.

Bankoff, G. (2004). Time is of the essence: disasters, vulnerability and history. *International Journal of Mass Emergencies and Disasters* **22**(3): 23-42.

Barnard, P. L., L. A. Owen, M. C. Sharma and R. C. Finkel (2001). Natural and human-induced landsliding in the Garhwal Himalaya of northern India. *Geomorphology* **40**: 21-35.

Beck, U. (1992). *Risk Society: Towards a New Modernity*. London: Sage.

Bell, R. and T. Glade (2004). Quantitative risk analysis for landslides - Examples from Bíldudalur, NW-Iceland. *Natural Hazards and Earth System Sciences* **4**(1): 117-131.

Bennett, L. (2005). Gender, caste and ethnic exclusion in Nepal: following the policy process from analysis to action. Paper presented at the World Bank Conference, 'New Frontiers of Social Policy: Development in a Globalizing World', December 12-15 2005.

Benson, C., J. Twigg and M. Myers (2001). NGO initiatives in risk reduction: an overview. *Disasters* **25**(3): 199-215.

Berger, A., F. Jouanne, R. Hassani and J. L. Mugnier (2004). Modelling the spatial distribution of present-day deformation in Nepal: how cylindrical is the Main Himalayan Thrust in Nepal? *Geophysical Journal International* **156**: 94-114.

Bernard, P. L., L. A. Owen, M. C. Sharma and R. C. Finkel (2001). Natural and human-induced landsliding in the Garwhal Himalaya of northern India. *Geomorphology* **40**: 21-35.

Bhattachan, K. B. and S. Webster. (2005). "Indigenous Peoples, Poverty Reduction and Conflict in Nepal." *International Labour Organisation Project to Promote ILO Policy on Indigenous and Tribal Peoples*. Retrieved 4/3/2006, from: http://www.ilo.org/public/english/standards/norm/egalitte/itpp/activity/nepal/nepal.study.pdf.

Bickerstaff, K. (2004). Risk perception research: socio-cultural perspectives on the public experience of air pollution. *Environment International*: 827-840.

Bienen, H., D. Kapur, J. Parks and J. Riedinger (1990). Decentralization in Nepal. *World Development* **18**(1): 61-75.

Bilham, R., V. K. Gaur and P. Molnar (2001). Himalayan Seismic Hazard. *Science* **293**(5534): 1442-1444.

Birkmann, J. (2006a). Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions. *Measuring Vulnerability to Natural Hazards - Towards a More Disaster Resilient Society*. J. Birkmann. Hong Kong: United Nations University Press: 9-54.

Birkmann, J., N. Fernando and S. Hettige (2006a). Measuring vulnerability in Sri Lanka at the local level. *Measuring Vulnerability to Natural Hazards - Towards Disaster Resilient Societies*. J. Birkmann. Hong Kong: United Nations University Press: 329-356.

Birkmann, J. and B. Wisner (2006b). Measuring the un-measurable - the challenge of vulnerability. *Source (UNU-EHS)* **5**: 1-60.

Bjonness, I. M. (1986). Mountain hazard perception and risk-avoiding strategies among the Sherpas of Khumbu Himal, Nepal. *Mountain Research and Development* **6**(4): 277-292.

Blaikie, P. and H. Brookfield (1987). *Land Degradation and Society*. London: Methuen.

Blaikie, P., K. Brown, M. Stocking, L. Tang, P. Dixon and P. Sillitoe (1997). Knowledge in action: local knowledge as a development resource and barriers to its incorporation in natural resource research and development. *Agricultural Systems* **55**(2): 217-237.

Blaikie, P., J. Cameron and D. Seddon (2001). *Nepal in Crisis: Growth and Stagnation at the Periphery*. Delhi: Adroit Publishers.

Blaikie, P., J. Cameron and J. Seddon (1977). *Centre, Periphery and Access in West-Central Nepal: Social and Spatial Relations of Inequality*. Norwich: University of East Anglia, UK.

Blaikie, P., T. Cannon, I. Davis and B. Wisner (1994). *At Risk: Natural Hazards, People's Vulnerability and Disasters*. London: Routledge.

Blaikie, P. M., J. Cameron and J. Seddon (2000). *The struggle for basic needs in Nepal*. Delhi: Adroit Publishers.

Blaikie, P. M. and J. S. S. Muldavin (2004). Upstream, downstream, China, India: the politics of environment in the Himalayan Region. *Annals of the Association of American Geographers* **94**(3): 520-548.

Bollin, C. and R. Hidajat (2006). Community-Based Risk Index: Pilot Implementation in Indonesia. *Measuring Vulnerability to Natural Hazards - Towards Disaster Resilient Societies*. J. Birkmann. Hong Kong: United Nations University Press: 271-289.

Bommer, J. J. and C. E. Rodriguez (2002). Earthquake-induced landslides in Central America. *Engineering Geology* **63**: 189-220.

Bookhagan, B., R. C. Thiede and M. R. Strecker (2005). Abnormal monsoon years and their control on erosion and sediment flux in the high, arid northwest Himalaya. *Earth Planet Science Letters* **231**(1-2): 131-146.

Brabb, E. E. (1993). Proposal for worldwide landslide hazard maps. *Landslides, Seventh International Conference and Field Workshop*. S. N. a. P. Wagner. Rotterdam: A.A. Balkena.

Bracken, L. J. and E. A. Oughton (2006). 'What do you mean?' The importance of language in developing interdisciplinary research. *Transactions of the Institute of British Geographers* **31**(3): 371-382.

Briggs, J. (2008). Indigenous knowledge and development. *The Companion to Development Studies*. V. Desai and R. B. Potter. London: Hodder Education: 107-111.

Brockington, D. and S. Sullivan (2003). Qualitative Research. *Development Fieldwork*. R. Scheyvens and D. Storey. London: Sage Publications: 57-74.

Brunsden, D., J. C. Doornkamp, P. G. Fookes, D. K. C. Jones and J. M. H. Kelly (2002). Large scale geomorphological mapping and highway engineering design. *Mapping in Engineering Geology*. J. S. Griffiths. Bath: The Geological Society: 113-139.

Bulmer, M., T. Farquhar, M. Roshan, S. S. Akhtar and S. K. Wahla (2007). Landslide hazards after the 2005 Kashmir earthquake. *Eos Transactions* **88**: 53.

Burgess, J. (1992). The art of interviewing. *The Student's Companion to Geography*. A. Rogers, H. Viles and A. Goudie. Oxford: Blackwell: 207-212.

Burningham, K. and G. Cooper (1999). Being constructive: social constructionism and the environment. *Sociology* **33**(2): 297-316.

Burton, I., R. Kates and G. White (1978). *The Environment as Hazard*. New York: Oxford University Press.

Burton, I., R. W. Kates and G. F. White (1993). *The Environment as Hazard*. London: The Guildford Press.

Bush, J., S. Moffatt and C. E. Dunn (2002). Contextualisation of local and global environmental issues in North-east England: implications for debates on globalisation and the 'risk society'. *Local Environment* **7**(2): 119-133.

Bush, J., S. M. Moffatt and C. E. Dunn (2001). 'Even the birds round here cough': stigma, air pollution and health in Teeside. *Health and Place* **7**: 47-56.

Caine, N. and P. K. Mool (1982). Landslides in the Kolpu Khola drainage basin, Middle Mountains, Nepal. *Mountain Research and Development* **2**(2): 157-173.

Cammack, P. (2002). Neoliberalism, the World Bank and the new politics of development. *Developmen Theory and Practice: Critical Perspectives*. U. Kothari and M. Minogue. Hampshire: Palgrave: 157-178.

Campbell, B. (1993). The Dynamics of Cooperation: Households and Economy in a Tamang Community of Nepal. *School of Development Studies*. Norwich: University of East Anglia. Ph.D.

Campbell, B. (2003). Resisting the environmental state. *Resistance and the State: Nepalese Experiences*. D. N. Gellner. New Delhi: Social Science Press: 83-112.

Campbell, B. (2004). Indigenous views on the terms of participation in the development of biodiversity conservation in Nepal. *Investigating Local Knowledge*. A. Bicker, P. Sillitoe and J. Pottier. Aldershot: Ashgate: 149-168.

Caplan, P. (2000). *Risk Revisited*. London: Pluto Press.

Cardinali, M., P. Reichenbach, F. Guzzetti, F. Ardizzone, G. Antonini, M. Galli, M. Cacciano, M. Castellani and P. Salvati (2002). A geomorphological approach to the estimation of landslide hazards and risks in Umbria, Central Italy. *Natural Hazards and Earth System Sciences* **2**: 57-72.

Cardona, O. D. (2004). The need for rethinking the concepts of vulnerability and risk from a holistic perspective: a necessary review and criticism for effective risk management. *Mapping Vulnerability*. G. Bankoff, G. Frerks and D. Hilhorst. 37-51: Earthscan.

Carney, D. (1998). Sustainable Rural Livelihoods: What Contribution Can We Make? London: Department for International Development.

Carson, B. (1985). Erosion and sedimentation processes in the Nepalese Himalaya *ICIMOD occasional paper no. 1*. Kathmandu: International Centre for Integrated Mountain Development.

Catane, S. G., H. B. Cabria, C. P. J. Tomarong, R. Saturay, M. Jr., M. A. H. Zarco and W. C. Pioquinto (2006). Catastrophic rock-debris avalanche at St. Bernard, Southern Leyte, Philippines. *Landslides*: DOI: 10.1007/s10346-006-0050-3.

Catane, S. G., M. A. H. Zarco and R. M. Saturay Jr. (2008). *Landslide risk reduction strategies and practices in the Philippines*. World Landslide Forum, United Nations University, Tokyo, Japan.

CBS (2002). Population of Nepal. Village Development Committees/Municipalities Population Census 2001. Kathmandu: Central Bureau of Statistics, National Planning Commission Secretariat, His Majesty's Government of Nepal. In collaboration with UNFPA Nepal (June 2002).

CBS (2006). Agriculture Census, Nepal, 2001-2002. Kathmandu: Central Bureau of Statistics.

CEAMP (2005). Village inquiry for rural and environmental system appraisal - Marming VDC, Sindhupalchok District. Chautara: Marmin Village Development Committee.

Chambers, R. (1983). *Rural-Development: Putting the Last First*. Harlow, Essex: Longman.

Chambers, R. (1997). Whose Reality Counts; Putting the Last First. London: Intermediate Technology Publications.

Chambers, R. and G. Conway (1992). Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. *IDS Discussion Paper 296*. Brighton: Institute of Development Studies.

Charman, J. H. (2001). Desk Studies. *Land Surface Evaluation for Engineering Practice*. J. S. Griffiths: Geological Society, Engineering Geology Special. 18: 19-21.

Charman, J. H. and J. S. Griffiths (1993). *Terrain evaluation methods for predicting relative hazards from mass movement, fluvial erosion and soil erosion in the developing world*. Natural Disasters: Protecting Vulnerable Communities, London: Thomas Telford.

Christensen, J. H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, I. Held, R. Jones, R. K. Kolli, W.-T. Kwon, R. Laprise, V. Magana Rueda, L. Mearns, C. G. Menendez, J. Raisanen, A. Rinke, A. Sarr and P. Whetton (2007). Regional Climate Projections. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. S. Solomon, D. Qin, M. Manninget al. Cambridge, UK and New York, USA: Cambridge University Press.

Christoplos, I. (2003). Actors in risk. *Natural Disasters and Development in a Globalizing World*. M. Pelling. London: Routledge: 95-109.

Christoplos, I., J. Mitchell and A. Liljelund (2001). Re-framing risk: The changing context of disaster mitigation and preparedness *Disasters* **25**(3): 185-198.

Cobb, K. M., C. D. Charles, H. Cheng and R. L. Edwards (2003). El Nino/Southern Oscillation and tropical climate during the last millennium. *Nature* **424**: 271-276.

Cook, B. R. (2008). Challenging assumptions - Controversy in Bangladesh: what sort of knowledge for what sort of flood management. *Geography* **93**(2): 114-118.

Cook, I. and M. Crang (1995). *Doing Ethnographies*. Norwich: Environmental Publications.

Cooke, R. U. and J. C. Doornkamp (1990). *Geomorphology in environmental management: a new introduction* Oxford: Clarendon.

Crang, M. (1997). Analyzing qualitative materials. *Methods in Human Geography. A Guide for Students doing a Research Project*. R. Flowerdew and D. Martin. Harlow, Essex: Pearson Education Ltd: 183-196.

Crang, M. and I. Cook (2007). *Doing Ethnographies*. London: Sage Publications.

Crozier, M. J. (2005). Multiple-occurrence regional landslide events in New Zealand: hazard management issues. *Landslides* **2**(4): 247-256.

Crozier, M. J. and T. Glade (2005). Landslide Hazard and Risk: Issues, Concepts and Approach. *Landslide Hazard and Risk*. M. J. Crozier, T. Glade and M. G. Anderson. London: John Wiley and Sons.

Cruden, D. M. and D. J. Varnes (1996). Landslide types and processes. *Landslides: Investigation and Mitigation*. A. K. Turner and R. L. Schuster. Washington D.C.: Special Report 247, Transportation Research Board, National Research Council 36-75.

Curtis, D. (2004). How we think what they think: thought styles in the management of international aid. *Policy Administration and Development* **24**: 415-423.

Cutter, S. L. (1995). Race, class and environmental justice. *Progress in Human Geography* **19**(1): 111-122.

Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in Human Geography* **20**(4): 529-539.

Cutter, S. L. (2006). Vulnerability to environmental hazards. *Hazards, Vulnerability and Environmental Justice*. S. L. Cutter. London: Earthscan: 71-82.

Cutter, S. L., B. J. Boruff and W. L. Shirley (2006). Social vulnerability to environmental hazards. *Hazards, Vulnerability and Environmental Justice*. S. L. Cutter. London: Earthscan: 115-131.

Dahal, N. (1998). Coping with climatic disasters in isolated hill communities of Nepal: the case of Rampur village in Okhaldhunga. *Understanding Vulnerability: South Asian Perspectives*. J. Twigg and M. R. Bhatt. London: Intermediate Technology Publications Ltd: 47-67.

Dahal, R. K. and S. Hasegawa (2008). Representative rainfall thresholds for landslides in the Nepal Himalaya. *Geomorphology* **100**(3-4): 429-443.

Dahal, R. K., S. Hasegawa, A. Nonomura, M. Yamanaka, S. Shakal and P. Paudyal (2008). Predictive modelling of rainfall-induced landslide hazard in the Lesser Himalaya of Nepal based on weights-of-evidence. *Geomorphology* **102**(3-4): 495-510.

Dai, F. C., C. F. Lee and S. J. Wang (2003). Characterization of rainfall-induced landslides. *Internarnational Journal of Remote Sensing* **24**(23): 4817-4834.

Davis, I. (2004). Progress in analysis of social vulnerability and capacity *Mapping Vulnerability*. G. Bankoff, G. Frerks and D. Hilhorst: Earthscan Publications.

de Haan, L. and A. Zoomers (2005). Exploring the frontiers of livelihood research. *Development and Change* **36**(1): 27-47.

Dekens, J. (2007). *Local Knowledge for Disaster Preparedness - A Literature Review*. Kathmandu: ICIMOD.

Department of Survey (2000). Topographic Map of Barhabise, Sindhupalchok District, Bagmati Zone. Sheet No. 2785 04. Kathmandu: Department of Survey, His Majesty's Government of Nepal: Map compiled from 1:50 000 scale aerial photography taken in 1992. Field verification undertaken in 1996.

Devereux, S. (1992). 'Observers are worried': learning the language and counting the people in northeast Ghana *Fieldwork in Developing Countries*. S. Devereux and J. Hoddinott. New York: Harvester Wheatsheaf: 43-56.

Devereux, S. and J. Hoddinott, Eds. (1992). *Fieldwork in Developing Countries*. Hemel Hempstead: Harvester Wheatsheaf.

DFID (2006). Reducing the Risk of Disasters - Helping to Achieve Sustainable Poverty Reduction in a Vulnerable World. A DfID Policy Paper. London: Department for International Development.

Dhital, M. R., B. N. Upreti, V. Dangol and A. N. Bhandari (1991). Engineering geological methods applied in mountain road survey. *Journal of Nepal Geological Society* **7**: 49-67.

Dikau, R., D. Brunsden, L. Schrott and M.-L. Ibsen (1996). *Landslide Recognition*: John Wiley and Sons, Chichester.

DoR and SDC (1989). Arniko Highway Rehabilitation Programme, Nepal: Inventory Report. Kathmandu, Nepal: The Government of Switzerland, Directorate for Development Cooperation and Humanitarian Aid (SDC) and His Majesty's Government of Nepal, Department of Roads: Volume 3 Annex 1: Geological Survey.

Douglas, M. (1985). *Risk Acceptability According to the Social Sciences*. New York: Russell Sage Foundation.

Douglas, M. (1992). *Risk and Blame: Essays in Cultural Theory*. London: Routledge.

Douglas, M. (1996). *Natural Symbols*. London: Routledge.

Douglas, M. and A. Wildavsky (1982). *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers*. Berkeley, California: University of California Press.

Dunlap, R. and W. R. Catton (1994). Struggling with Human Experimentalism: The Rise, Decline and Revitalization of American Sociology. *American Sociologist* **Spring 1994**: 5-30.

Dunn, K. (2000). Interviewing. *Qualitative Methods in Human Geography*. I. Hay. Oxford: Oxford University Press: 50-82.

Dunning, S. A., W. A. Mitchell, N. J. Rosser and D. N. Petley (2007). The Hattian Bala rock avalanche and associated landslides triggered by the Kashmir Earthquake of 8 October 2005. *Engineering Geology* **93**(3-4): 130-144.

Ellen, R. F. (1984). *Ethnographic Research: A Guide to General Conduct*. London: Academic Press.

Elliot, J. A. (2008). Development and social welfare/human rights. *The Comparison to Development Studies.* . V. Desai and R. B. Potter. London: Hodder Education: 40-45.

Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development Studies* **35**(1): 1-38.

Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries*. Oxford, UK.: Oxford University Press.

Emanuel, K. (2005). Increasing destructiveness of tropical cyclones over the past 30 years. *Nature (Letters)* **436**: 686-688.

Emel, J. and R. Peet (1989). Resource management and natural hazards. *New Models in Geography. Vol. 1.* R. Peet and N. Thrift. London: Unwin Hyman.

England, K. (1994). Getting personal: reflexivity, positionality, and feminist research. *Professional Geographer* **46**: 80-89.

Escobar, A. (1991). Anthropology and the development encounter: the making and marketing of develoment anthropology. *American Ethnologist* **18**: 658-682.

Escobar, A. (1995). *Encountering Development: The Making and Unmaking of the Third World*. Princeton, NJ: Princeton University Press.

Escobar, A. (1999). After nature: Steps to an antiessentialist political ecology. *Current Anthropology* **40**(1): 1-30.

FAO (2005). Global Forest Resources Assessment (2005). Forestry Paper 147. Rome, Italy: Forestry Department, Food and Agriculture Organisation of The United Nations: 320.

Fell, R. and D. Hartford (1997). Landslide risk management. *Landslide Risk Assessment*. D. Cruden and R. Fell. Rotterdam: Balkema: 51-108.

Finucane, M. L., P. Slovic, C. K. Mertz, J. Flynn and T. A. Satterfield (2000). Gender, race, and perceived risk: the 'white male' effect. *Health, Risk and Society* **2**: 159-172.

Fischer, F. (2000). *Citizens, Experts, and the Environment: The Politics of Local Knowledge*. Durham, NC: Duke University Press.

Fischer, F. (2005). Are scientists irrational? Risk assessment in practical reason. *Science and Citizens*. M. Leach, I. Scoones and B. Wynne. London: Zed Books: 54-65.

Folbre, N. (1986). Cleaning house: new perspectives on households and economic development. *Journal of Development Economics* **22**(1): 5-40.

Fookes, P. G. (1997). Geology for engineers: the geological model, prediction and performance. *Quarterly Journal of Engineering Geology* **30**: 290-424.

Fookes, P. G., F. J. Baynes and J. N. Hutchinson (2000). *Total geological history: a model approach to the anticipation, observation and understanding of site conditions.* GeoEng 2000: An International Conference on Geotechnical and Geological Engineering.

Forsyth, T. (2003). *Critical Political Ecology*. London: Routledge.

Fort, M. (2000). Glaciers and mass wasting processes: their influence on the shaping of the Kali Gandaki valley (higher Himalaya of Nepal). *Quaternary International* **65/66**: 101-119.

Fox, N. J. (1999). Postmodern reflections on 'risk', 'hazards' and life choices. *Risk and Sociocultural Theory*. D. Lupton. Cambridge: Cambridge University Press: 12-33.

Froehlich, W., E. Gil, I. Kaza and L. Starkel (1990). Thresholds in the transformation of slopes and river channels in the Darjeeling Himalaya, India. *Mountain Research and Development* **10**(4): 301-312.

Gabet, E. J., D. W. Burbank, J. K. Putkonen, B. A. Pratt-Sitaula and T. Ojha (2004). Rainfall thresholds for landsliding in the Himalayas of Nepal. *Geomorphology* **63**(3-4): 131-143.

Gadgil, S., P. N. Vinayachandran and P. A. Francis (2004). Extremes of the Indian summer monsoon rainfall, ENSO and equatorial Indian Ocean Oscillation. *Geophysical Research Newsletters* **31**(12): 1-4.

Gerrard, J. (1994). The landslide hazard in the Himalayas: geological control and human action. *Geomorphology* **10**: 221-230.

Gerrard, J. and R. A. M. Gardner (2000a). Relationship between rainfall and landsliding in the Middle Hills, Nepal. *Norsk Geografisk Tidsskrift* **54**: 74-81.

Giddens, A. (1990). *The Consequences of Modernity*. Cambridge: Polity Press.

Glade, T. (2000). Modelling landslide-triggering rainfalls in different regions of New Zealand - the soil water status model. *Zeitschrift fur Geomorphologie, Supplementband* **122**: 63-84.

Glade, T. (2003). Vulnerability assessment in landslide risk analysis. *Die Erde* **134**(2): 123-146.

Glade, T. and M. J. Crozier (2005a). The nature of landslide hazard impact. *Landslide Hazard and Risk*. T. Glade, M. G. Anderson and M. J. Crozier. Chichester: John Wiley.

Gough, I., J. A. McGregor and L. Camfield (2007). Theorising wellbeing in international development. *Wellbeing in Developing Countries*. I. Gough and J. A. McGregor. Cambridge: Cambridge University Press: 3-43.

Graham, E. (1997). Philosophies and underlying human geography research. *Methods in Human Geography*. Harlow, Essex: Pearson Education Ltd.

Graner, E. (1997). Kami (blacksmiths) today: Forests and livelihood security. *Contributions to Nepalese Studies* **24**(2): 217-231.

Guthman, J. (1997). Representing crisis: The theory of Himalayan environmental degradation and the project of development in post-Rana Nepal. *Development and Change* **28**: 45-69.

Haack, B. N. and A. Rafter (2006). Urban growth analysis and modelling in the Kathmandu Valley, Nepal. *Habitat International* **30**(4): 1056-1065.

Haghebaert, B. (2001). Roundtable Comments. Workshop on Vulnerability Theory and Practice. Netherlands: Wageningen Agricultural University.

Hajer, M. (1995). *The Politics of Environmental Discourse*. Oxford: Clerendon.

Halcrow, A. P. (1999). Stage 2 Detailed Site-Specific QRA Report - Technical Report to Geotechnical Engineering Office. Hong Kong Government.

Hall, N. (1999). "The perception of risk at local levels, and ways to measure community vulnerability." Retrieved 01/02/2007, from: http://www.benfieldhrc.org/disaster_studies/projects/imp_com_dis_mit_docs/Hall%20N.rtf.

Hannigan, J. A. (1995). *Envrionmental Sociology. A Social Constructionist Perspective*. London: Routledge.

Hansen, M. J. (1984). Strategies for classification of landslides. *Slope Instability*. D. Brunsden and D. B. Prior. Chichester: John Wiley and Sons: 1-25.

Harmsworth, G. and B. Raynor (2005). Cultural Consideration in Landslide Risk Perception. *Landslide Hazard and Risk*. M. J. Crozier, T. Glade and M. G. Anderson. London: John Wiley: 219-249.

Hart, A., P. Lamichhane, P. Jha and M. Subba (2003). *The incidence of reported landslide activity in Nepal*. Proceedings of the PIARC Seminar Kathmandu.

Hart, G. (2001). Development critiques in the 1990s: cul de sac and promising paths. *Progress in Human Geography* **25**(4): 649-658.

Hasegawa, S., R. K. Dahal, M. Yamanaka, N. P. Bhandary, R. Yatabe and H. Inagaki (2009). Causes of large-scale landslides in the lesser Himalaya of central Nepal. *Environmental Geology* **57**(6): 1423-1434.

Hatlebakk, M. (2007). LSMS data quality in Maoist influenced areas of Nepal. Bergen: Chr. Michelsen Institute Working Paper: 14.

Haynes, K., J. Barclay and N. Pidgeon (2008). Whose reality counts? Factors affecting the perception of volcanic risk. *Journal of Volcanology and Geothermal Research* **172**: 259-272.

Heijmans, A. (2004). From Vulnerability to Empowerment. *Mapping Vulnerability - Disasters, Development and People*. G. Bankoff, G. Frerks and D. Hilhorst. London: Earthscan: 115-127.

Herz, R. and J. Luber (1995). *Studying Elites: Using Qualitative Methods*. London: Sage Publications Ltd.

Hewitt, K. (1983a). *Interpretations of Calamity*. London: Allen and Unwin.

Hewitt, K. (1997). *Regions of Risk - A Geographical Introduction to Disasters*. Harlow: Addison Wesley Longman Ltd.

Hewitt, K. and I. Burton (1971). *The hazardousness of place: a regional ecology of damaging events*. Toronto: University of Toronto Press.

Heyer, J. (1992). Contrasts in village-level fieldwork: Kenya and India. *Fieldwork in Developing Countries*. S. Devereux and J. Hoddinott. Hemel Hempstead: Harvester Wheathsheaf: 200-216.

Hilhorst, D. (2004). Complexity and diversity: unlocking social domains of disaster response. *Mapping Vulnerability - Disasters, Development and People*. G. Bankoff, G. Frerks and D. Hilhorst. London: Earthscan: 52-66.

Hilhorst, D. and G. Bankoff (2004). Introduction: mapping vulnerability. *Mapping Vulnerability - Disasters, Development and People*. G. Bankoff, G. Frerks and D. Hilhorst: Earthscan. 1-9.

Horlick-Jones, T., J. Sime and N. Pidgeon (2003). The social dynamics of environmental risk perception: implications for risk communication research and practice. *The Social Amplification of Risk*. N. Pidgeon, R. E. Kasperson and P. Slovic. Cambridge: Cambridge University Press: 262-285.

Hovius, N., D. Lague and S. Dadson (2004). Processes, rates and patterns of mountain-belt erosion. *Mountain Geomorphology*. P. N. Owens and O. Slaymaker. London: Edward Arnold Publishers: 109-131.

Hufschmidt, G., M. Crozier and T. Glade (2005). Evolution of natural risk: research framework and perspectives. *Natural Hazards and Earth System Sciences* **5**: 375-387.

INFRAS (1995). Development Trends in Dolakha and Sindhupalchok, Nepal 1975 - 1995. Zurich/Kathmandu: Prepared by INFRAS for the Swiss Development Cooperation (SDC).

International Landslide Centre (2009). Landslide fatality database. Durham: International Landslide Centre, Department of Geography, Durham University.

Ives, J. D. (2004). *Himalayan Perceptions - Environmental change and the well-being of mountain peoples*. Oxon: Routledge.

Ives, J. D. and B. Messerli (1989). *The Himalayan Dilemma: Reconciling Development and Conservation*. London: Routledge.

Jackson, A. M. and R. Bilham (1994). Constraints on Himalayan deformation inferred from vertical velocity fields in Nepal and Tibet. *Journal of Geophysical Research* **99**(13): 897-912.

Jacoby, H. G. (2000). Access to markets and the benefits of rural roads. *The Economic Journal* **110**: 713-737.

Jasanoff, S. (1998). The political science of risk perception. *Reliability Engineering and System Safety* **59**: 91-99.

Jazeel, T. and C. McFarlane (2010). The limits of responsibility: a postcolonial politics of academic knowledge production. *Transactions of the Institute of British Geographers* **Forthcoming**.

Johnson, K., E. Olson and S. Manandhar (1982). Environmental knowledge and response to natural hazards in mountainous Nepal. *Mountain Research and Development* **2**(2): 175-188.

Jones, P. and N. Macdonald (2007). Getting it wrong first time: building an interdisciplinary research relationship. *Area* **39**(4): 490-498.

Jones, S. (1996). Discourses on land degradation in the Uluguru Mountains, Tanzania: Evolution and Influences. *Journal of Rural Studies* **12**(2): 187-199.

Jones, S. (1999). From meta-narratives to flexible frameworks: an actor level analysis of land degradation in Highland Tanzania. *Global Environmental Change* **9**: 211-219.

Joshi, A. L. (1998). *Underlying Causes of Deforestation and Participatory Forest Management Policy in Nepal*. Proceedings of the IGES International Workshop on Forest Conservation Strategies for the Asia and Pacific Region. Retrieved 06/04/2008, from: http://www.iges.or.jp/en/fc/phase1/1ws-contents.htm.

Joshi, M. and T. D. Mason (2007). Land tenure, democracy, and insurgency in Nepal. *Asian Survey* **47**(3): 393-414.

Kamp, U., B. J. Growley, G. A. Khattak and L. A. Owen (2008). GIS-based landslide susceptibility mapping for the 2005 Kashmir earthquake region. *Geomorphology* **101**: 631-642.

Kane, R. P. (1998). Extremes of the ENSO phenomenon and Indian summer monsoon rainfall. *International Journal of Climatology* **18**(7): 775-791.

Karnawati, D., T. F. Fathani, I. Sudarno and B. Andayani (2008). *Development of community-based landslide early warning system in Indonesia*. World Landslide Forum, United Nations University, Tokyo, Japan.

Kasperson, J. X., R. E. Kasperson and B. L. Turner (1995). *Regions at Risk: Comparisons of Threatened Environments*. Tokyo: United Nations University Press.

Katz, C. (1994). Playing the field: questions of fieldwork in geography. *Professional Geographer* **46**: 67-72.

Keefer, D. K. (1984). Landslides caused by earthquakes. *Geological Society of America Bulletin* **95**: 406-421.

Keefer, D. K. and M. C. Larsen (2007). Assessing landslide hazards. *Science* **316**: 1136-1138.

Kesby, M., S. Kindon and R. Pain (2005). 'Participatory' approaches and diagramming techniques. *Methods in Human Geography - A guide for students doing a research project*. R. Flowerdew and D. Martin. Harlow: UK: Pearson Education Limited: 144-166.

Khole, M. (2000). Anomalous warming over the Indian Ocean during 1997 El-Nino. *Meteorology and Atmospheric Physics* **75**: 1-9.

Kindon, S. (1995). Dynamics of Difference: Exploring Empowerment Methodologies with Women and Men in Bali. *New Zealand Geographer* **51**(1): 10-12.

Kothari, U. and M. Minogue, Eds. (2002). *Development Theory and Practice: Critical Perspectives*. Hampshire: Palgrave.

Laurie, N., R. Andolina and S. Radcliffe (2003). Indigenous professionalization: Transnational social reproduction in the Andes. *Antipode* **35**: 463-491.

Lavell, A. (1994). Prevention and mitigation of disasters in Central America: vulnerability to disasters at the local level. *Disasters, Development and Environment*. A. Varley. Chichester: John Wiley and Sons: 49-63.

Lavers, T. (2007). Asking people what they want or telling them what they 'need'? Contrasting a theory of human need with local expressions of goals. *WeD Working Paper 28*. Bath: University of Bath: Wellbeing in Developing Countries Research Group.

Le Mare, R. A. (2007). Exploring the Power to Change: Fair Trade, Development and Handicraft Production in Bangladesh. *Department of Geography*. Durham: Durham University. Unpublished Ph.D. thesis.

Leach, M. and R. Mearns (1996). *The Lie of the Land: Challenging Received Wisdom on the African Environment*. Oxford: James Currey.

Leach, M. and I. Scoones (2005). Science and citizenship in a global context. *Science and Citizens. Globalization and the Challenge of Engagement*. M. Leach, I. Scoones and B. Wynne. London: Zed Books: 15-38.

Leach, M., I. Scoones and B. Wynne (2005). Introduction: science, citizenship and globalisation. *Science and Citizens. Globalization and the Challenge of Engagement*. M. Leach, I. Scoones and B. Wynne. London: Zed Books: 3-14.

Lee, E. M. and D. K. C. Jones (2004). *Landslide Risk Assessment*. London: Thomas Telford Publishing.

Legono, D., A. Pamudji, T. F. Fathani and I. Prabowo (2008). *2008*. World Landslide Forum, United Nations University, Tokyo, Japan.

Lein, H. (2000). Hazards and 'forced' migration in Bangladesh. *Norwegian Journal of Geography* **54**: 122-127.

Leinbach, T. R. (1995). Transport and third world development: Review, issues, and prescription. *Journal of Transport Research A* **29**(5): 337-344.

Leslie, H. and D. Storey (2003). Entering the field. *Development Fieldwork. A Practical Guide*. R. Scheyvens and D. Storey. London: Sage Publications: 119-138.

Lindell, M. K. and R. W. Perry (2004). *Communicating Environmental Risk in Multiethnic Communities*. Thousand Oaks, California: Sage Publications.

Long, N. and J. D. van der Ploeg (1994). Heterogeneity, actor and structure: towards a reconstitution of the concept of structure. *Rethinking Social Development: Theory, Research and Practice*. D. Booth. Harlow, Essex: Longman Scientific and Technical.

Lupton, D. (1999a). *Risk*. London: Routledge.

Lupton, D. (1999b). *Risk and Socio-cultural Theory: New Directions and Perspectives*. Cambridge: Cambridge University Press.

Macnaghten, P. and J. Urry (1998). *Contested Natures*. London: Sage.

Madge, C. (1997). The ethics of research in the 'third world'. *Postgraduate Fieldwork in Developing Areas: A Rough Guide*. E. Robson and K. Willis. Keele: Developing Areas Research Group, Royal Geogrpahical Society.

Mahat, T. B. S. (1987b). Human impact of some forests of the Middle Hills of Nepal: 4, a detailed study of southeast Sindhu Palchok. *Mountain Research and Development* **7**(2): 111-134.

Mahat, T. B. S., D. M. Griffin and K. R. Shepherd (1986a). Human impact on some forests of the middle hills of Nepal. Part 1. Forestry in the context of the traditional resource of the state. *Mountain Research and Development* **6**(3): 223-232.

Mahat, T. B. S., D. M. Griffin and K. R. Shepherd (1986b). Human impact on some forests of the Middle Hills of Nepal. Part 2.Some major human impacts before 1950 on the forests of Sindhu Palchok and Kabhre Palanchok. *Mountain Research and Development* **6**(4): 325-334.

Mahat, T. B. S., D. M. Griffin and K. R. Shepherd (1987a). Human impact on some forests of the middle hills of Nepal. Part 3. Forest in the subsistence economy of Sindhu Palchok and Kabhre Palanchok. *Mountain Research and Development* **7**(1): 53-70.

Martine, G. (2007). The State of World Population 2007. Unleashing the Potential of Urban Growth. A. Marshall. New York: United Nations Population Fund (UNFPA). Retrieved 17/07/09, from: http://www.unfpa.org/swp/2007/presskit/pdf/sowp2007_eng.pdf.

Massey, C., F. Alpass, R. Flett, K. Lewis, S. Morris and F. Sligo (2006). Crossing fields: the cause of a multi-disciplinary research team. *Qualitative Research* **6**: 131-149.

Mazzucato, V. and D. Niemaijer (2002). Population growth and environment in Africa: local informal institutions, the missing link. *Economic Geography* **18**: 171-193.

Messerschmidt, D. A. (1987). Conservation and society in Nepal: traditional forest management and innovative development. *Lands at Risk in the Third World: Local Level Perspectives*. P. D. Little, M. M. Horowitz and A. E. Nyerges. Boulder: Westview Press: 373-397.

Miller, C. J. (2000). *Decision Making in Village Nepal.* Kathmandu: Pilgrims Publishing.

Miller, K. J. (1984). *The International Karakorum Project.* Proceedings of the International Conference The Royal Geographical Society, London: Cambridge University Press.

Ministry of Home Affairs (1982). Natural Disaster Relief Act (Unofficial Translation). Kathamndu, Nepal: Ministry of Home Affairs, His Majesty's Government of Nepal: 11.

Ministry of Home Affairs (1996). National Action Plan on disaster Management in Nepal. Kathmandu: His Majesty's Government, Ministry of Home Affairs.

Mitchell, T. C. (2006). Building a Disaster Resilient Future: Lessons from Participatory Research in St. Kitts and Montserrat. *Department of Geography*. London: University College London. Ph.D.: 359.

Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters* **23**(1): 1-18.

Moughtin, C. (1984). Barkulti in the Yasmin valley: A study of traditional settlement form as a reponse to environmental hazard. *The International Karakorum Project. Vol. 2, Proceedings of the international conference held at the Royal Geographical Society, London.* K. J. Miller. Cambridge: Cambridge University Press: 307-322.

Murdoch, J. and J. Clark (1994). Sustainable knowledge. *Geoforum* **25**(2): 115-132.

Murphy, R. (1994). The sociological construction of science without nature. *Sociology* **28**: 957-974.

Murshed, S. M. and S. Gates (2005). Spatial-horizontal inequality and the Maoist Insurgency in Nepal. *Review of Development Economics* **9**(1): 121-134.

National Planning Commission (2002). Tenth Plan 2002-2007 (Unofficial Translation). Kathmandu: National Planning Commission, His Majesty's Government of Nepal.

National Planning Commission (2002a). The Tenth Plan. *Road transportation*. National Planning Commission of Nepal. Kathmandu: Government of Nepal: 335-359.

National Planning Commission (2002b). The Tenth Plan. *Population, environment and natural disaster management*. National Planning Commission. Kathmandu, Nepal: Government of Nepal: 413-435.

National Planning Commission (2007). Three Year Interim Plan 2007-2010 (Unofficial Translation). Kathmandu: National Planning Commission, His Majesty's Government of Nepal.

Nayava, J. L. (2004). The temporal variations in rainfall in Nepal since 1971 to 2000. *Journal of Hydrology and meteorology* **1**(1): 24-33.

NCDM (2008). Policy on Disaster Management. Kathmandu: National Centre for Disaster Risk Management and Oxfam: 15.

Nichols, P. (1991). *Social Survey Methods: A Fieldguide for Development Workers*. Oxford: Oxfam.

Nightingale, A. (2003). Nature-society and development: social, cultural and ecological change in Nepal. *Geoforum* **34**: 525-540.

Nightingale, A. (2005). "The experts taught us what we know": professionalisation and knowledge in Nepalese community forestry. *Antipode* **37**(3): 581-604.

O'Brian, G., P. O'Keefe, J. Rose and B. Wisner (2006). Climate change and disaster management. *Disasters* **30**(1): 64-80.

O'Keefe, P., K. Westgate and B. Wisner (1976). Taking the naturalness out of natural disasters. *Nature* **260**: 566-567.

Oliver-Smith, A. (1979). Anthropological perspectives on disaster and social change. *Disasters* **3**(1): 95-101.

Oliver-Smith, A. and S. M. Hoffman (1999). *The Angry Earth: Disasters in Anthropological Perspective*. New York: Routledge.

Olson, R. S. and D. C. Nilson (1982). Public policy analysis and hazards research: natural complements. *Social Science Journal* **19**: 89-103.

Oven, K. J. (2005). The Spatial Patterns and Controls of Fatal Landslides *Department of Geography*. Durham: Durham University, UK. M.Sc. by Research.

Owen, L. A., E. Derbyshire and M. Fort (1998). The Quaternary Glacial history of the Himalaya. *Quaternary Proceedings* **6**: 91-120.

Owen, L. A., U. Kamp, G. A. Khattak, E. L. Harp, D. K. Keefer and M. A. Bauer (2008). Landslides triggered by the 8 October 2005 Kashmir earthquake. *Geomorphology* **94**(1-2): 1-9.

Owen, L. A., M. Sharma and R. Bigwood (1995). Mass movement hazard in the Garhwal Himalaya: the effects of the 20th October 1991 Garhwal earthquake and the July-August monsoon season. *Geomorphology and land management in a changing environment*. D. F. M. McGregor and D. A. Thompson. London: Wiley: 69-88.

Owen, L. A., M. Sharma and R. Bigwood (1996). Landscape modification and geomorphological consequences of the 20 October 1991 earthquake and the July-August 1992 monsoon in the Garhwal Himalaya *Zeitschrift fur Geomorphologie* **103**: 359-372.

Pai, D. S. (2004). A possible mechanism for the weakening of El Nino-monsoon relationship during the recent decade. *Meteorology and Atmospheric Physics* **86**(3-4): 143-157.

Pain, R. (2004). Social geography: participatory research. *Progress in Human Geography* **28**(5): 652-663.

Pandey, M. R., R. P. Tandukar, J. P. Avouac and T. Heriier (1999). Seismotectonics of the Nepal Himalaya from a local seismic network. *Journal of Asian Earth Sciences* **17**: 703-712.

Pantha, B. and B. R. Sharma (2003). Chapter 2: Population size, growth and distribution. *Population Monograph of Nepal 2003.* . Kathmandu: Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal. Volume 1: 37-86.

Pantha, B. R., R. Yatabe and N. P. Bhandary (2008). GIS-based landslide susceptibility zonation for roadside slope repair and maintenance in the Himalayan region. *Episodes* **31**(4): 384-391.

Pelling, M. (1997). Participation, social capital and vulnerability to urban flooding in Guyana. *Journal of International Development* **10**(4): 469-486.

Pelling, M. (1999). The political ecology of flood hazard in urban Guyana. *Geoforum* **30**: 249-261.

Pelling, M. (2003). Emerging concerns. *Natural Disasters and Development in a Globalising World*. M. Pelling. London: Routledge: 233-243.

Peters, E. and P. Slovic (1996). The role of affect and world-views as orienting dispositions in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology* **26**: 1427-1453.

Petley, D. N. (2008). *The global occurrence of fatal landslides 2007*. Proceedings of the World Landslide Forum Satellite Conference, Sendai, Japan: Japan Landslide Society.

Petley, D. N. (2009). "Earthquake induced landslides." *On the Slide* Retrieved 17/07/09, from: http://daveslandslideblog.blogspot.com/2009/07/earthquake-induced-landslides.html.

Petley, D. N., S. A. Dunning and N. J. Rosser (2005a). The analysis of global landslide risk through the creation of a database of worldwide landslide fatalities *Landslide Risk Management*. O. Hungr, R. Fell, R. Couture and E. Eberhardt. Amsterdam A T Balkema: 367-374.

Petley, D. N. and G. J. Hearn (2003). R7815 Landslide Risk Assessment in the Rural Sector: Scott Wilson and The Department for International Development.

Petley, D. N., G. J. Hearn and A. Hart (2005b). Towards the development of a landslide risk assessment for rural roads in Nepal. *Landslide Hazard and Risk*. T. Glade, M. Anderson and M. J. Crozier. Chichester: Wiley: 597-620.

Petley, D. N., G. J. Hearn, A. Hart, N. J. Rosser, S. A. Dunning, K. J. Oven and W. A. Mitchell (2007). Trends in landslide occurrence in Nepal. *Natural Hazards* **43**: 23-34.

Petley, D. N. and N. J. Rosser (in press). *On climate change and landslides in Asia over the next century*. Accepted for publication in the Proceedings of the International Conference on Slopes, Kuala Lumpur, Malaysia.

Pettigrew, J. (2004). Living between the Maoists and the army in rural Nepal. *Himalayan 'People's War' Nepal's Maoist Rebellion*. M. Hutt. London: Hurst and Co.: 261-283.

Pettigrew, J., S. Shneiderman and I. Harper (2004). Relationships, complicity and representation: conducting research in Nepal during the Maoist insurgency. *Anthropology Today* **20**(1): 20-25.

Pidgeon, N., C. Hood, D. Jones, B. Turner and R. Gibson (1992). Risk perception. Risk analysis, perception and management. *Report of the Royal Society study group*. London: The Royal Society 89-134.

Pidgeon, N. F. and J. Beattie (1998). The psychology of risk and uncertainty. *Handbook of Envrionmental Risk Assessment and Management*. P. Calow. Oxford: Blackwell: 289-318.

Pigg, S. L. (1996). The credible and the credulous: the question of "villagers' beliefs" in Nepal. *Cultural Anthropology* **11**(2): 160-201.

Pilgrim, N. K. (1999). Landslides, risk and decision-making in Kinnaur District: bridging the gap between science and public opinion. *Disasters* **23**(1): 45-65.

Plant, Y. P. (1964). Nepal's recent trade policy. *Asian Survey* **4**(5): 947-957.

Plough, A. and S. Krimsky (1987). The emergence of risk communication studies: social and political context. *Science, Technology and Human Values* **12**(3): 4-10.

POPIN (2003). World Population Prospects - The 2002 Revision: United Nations Population Information Network. Retrieved 04/06/2005, from: http://www.un.org/esa/population/publications/wpp2002/WPP2002-HIGHLIGHTSrev1.PDF.

Potter, R. (1999). *Geographies of Development*. London: Harlow.

Pradhan, B. K. (2007). *Disaster Preparedness for Natural Hazards: Current Status in Nepal*. Kathmandu: ICIMOD.

Pradhan, R. and A. Shrestha (2005). Ethnic and caste diversity: implications for development. *Working Paper Series No. 4 Nepal Resident Mission*. Kathmandu: Asian Development Bank.

Preston, N. J. (2000). Feedback effects of rainfall-triggered shallow landsliding *Landslides in Research, Theory and Practice*. E. Bromhead, N. Dixon and M.-L. Ibsen. Cardiff: Thomas Telford: 1239-1244.

Radcliffe, S. A. and N. Laurie (2006). Culture and development: taking culture seriously in development for Andean indigenous people. *Environment and Planning D: Society and Space* **24**: 231-248.

Rankin, K. N. (2004). *The Cultural Politics of Markets: Economic Liberalization and Social Change in Nepal*. London: Pluto Press.

Razavi, S. (1992). Fieldwork in a familiar setting: the role of politics at the national, community and household levels. *Fieldwork in Developing Countries*. S. Devereux and J. Hoddinott. Hemel Hempstead: Harvester Wheatsheaf: 152-163.

Regmi, M. C. (1963). *Land Tenure and Taxation in Nepal, Vol. 1, The State as Landlord: Raiker Tenure*. Berkerley Institute of International Studies, University of California.

Rigg, J. (2007). *An Everyday Geography of the Global South*. Abingdon: Routledge.

Robson, C. (2002). *Real World Research. A Resource for Social Scientists and Practitioner-Researchers*. Oxford: Blackwell Publishing.

Rodriguez, C. E., J. J. Bommer and R. J. Chandler (1999). Earthquake-induced landslides: 1980-1997. *Soil Dynamics and Earthquake Engineering* **18**(5): 325-346.

Rose, G. (1997). Situating knowledges: positionality, reflexivities and other tactics. *Progress in Human Geography* **21**(3): 305-320.

Royal Society (1992). Risk Analysis, Perception and Management. London: Royal Society.

Rybar, J. (1997). Increasing impact of anthropogenic activities upon natural slope stability. *Proceedings of the International Symposium on Engineering Geology and the Environment*. P. G. Marinos, G. C. Koukis, G. C. Tsiambaos and G. C. Stournaras. 23-27 June 1997, Athens, Greece: A.A. Balkema: 1015-1020.

Sah, M. P. and R. P. Mazari (1998). Anthropological accelerated mass movement, Kulu Valley, Himachal Pradesh, India. *Geomorphology* **26**(1-3): 123-138.

Sarewitz, D. and R. J. Pielke (2001). Extreme events: a research and policy framework for disasters in context. *International Geology Review* **43**: 406-418.

Scheyvens, R., B. Nowak and H. Scheyvens (2003). Ethnical issues. *Development Fieldwork. A Practical Guide*. R. Scheyvens. London: Sage Publications: 139-166.

Scheyvens, R. and D. Storey (2003). *Development Fieldwork. A Practical Guide*. London: Sage Publications.

Schmidt, K. M., J. J. Roering, J. D. Stock, W. E. Dietrich, D. R. Montgomery and T. Schaub (2001). The variability of root cohesion as an influence on shallow landslide susceptibility in the Oregon Coast Range. *Canadian Geotechnical Journal* **38**: 995-1024.

Schmuck-Widmann, H. (1996). Living with floods. Survival strategies of char dwellers in Bangladesh. Berlin: ASA program of Carl-Duisberg-Gesellschaft e.V.

Schmuck-Widmann, H. (2001). Facing the Jamuna River: Indigenous and Engineering Knowledge in Bangladesh. Dhaka: Bangladesh Resource Centre for Indigenous Knowledge.

Schneiderman, S. and M. Turin (2004). The path to *jan sarkar* in Dolakha district: towards an ethnography of the Maoist movement. *Himalayan 'People's War' Nepal's Maoist Rebellion*. M. Hutt. London: Hurst and Company: 79-111.

Schuster, R. L. and L. M. Highland (2001). Socioeconomic and environmental impacts of landslides in the Western Hemisphere: USGS Open-File Report, 01-276.

Schuster, R. L. and G. F. Wieczorek (2002). *Landslide triggers and types*. Proceedings of the first European Conference on Landslides, Prague: A.A. Balkena, Netherlands.

Scoones, I. and J. Thompson, Eds. (1994). *Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice*. London: Intermediate Technology Publications.

Scott, R. A. and A. R. Shore (1979). *Why sociology does not apply: a study of the use of sociology in public policy*. London: Elsevier.

SDC (1997). Nepal-Switzerland Co-operation Project on Hazard Mitigation in northern Sunkoshi and Bhote Koshi watercatchment areas (H.M.W.A.) (Central-Eastern Nepal). Part 1: Final Report. Kathmandu: Swiss National Committee of the UN International Decade for Natural Disaster Reduction (IDNDR), Swiss National Hydrological and Geological Survey, The Government of Switzerland Swiss Agency for Development and Co-operation, His Majesty's Government of Nepal Consulting Committee.

Searle, M. P., R. D. Law, L. Godin, K. P. Larson, M. J. Streule, J. M. Cottle and M. J. Jessup (2008). Defining the Himalayan Main Central Thrust in Nepal. *Journal of the Geological Society, London* **165**: 523-534.

Seddon, D. (1987). *Nepal - A State of Poverty*. New Delhi: Vikas Publishing.

Seddon, D., J. Adhikari and G. Gurung (2002). Foreign labour migration and the remittance economy of Nepal. *Critical Asian Studies* **34**(1): 19-40.

Shaha, R. (1973). Foreign policy. *Nepal in Perspective*. P. S. J. B. Rana and K. P. Malla. Kathmandu: CEDA.

Sharma, S. (2003). The Maoist movement: an evolutionary perspective. *Understanding the Maoist Movement of Nepal*. D. Thapa. Kathmandu: Chautari Publishers.

Shepherd, A. (1998). *Sustainable Rural Development*. Basingstoke and London: Macmillan Press.

Shroder, J. F. (1998). Slope failure and denudation in the western Himalaya. *Geomorphology* **26**(1-3): 81-105.

Shroder, J. F. and M. P. Bishop (1998). Mass movement in the Himalaya: new insights and research directions. *Geomorphology* **26**(1-3): 13-35.

Sidaway, J. D. (1990). In other worlds: on the politics of research by 'First World' geographers in the 'Third World'. *Area* **24**: 403-408.

Sidle, R. C., A. D. Ziegler, J. N. Negishi, A. R. Nik, R. Siew and F. Turkelboom (2006). Erosion processes in steep terrain - truths, myths and uncertainties related to forest management in Southeast Asia. *Forest Ecology and Management* **224**(1-2): 199-225.

Sillitoe, P. (2004). Interdisiplinary experiences: Working with indigenous knowledge in development. *Interdisciplinary Science Reviews* **29**(1): 1-18.

Sjoberg, L., Ed. (1989). *Risk and Society: Studies in Risk Generation and Reactions to Risk*. London: Allen and Unwin.

Skelton, T. (2001). Cross-cultural research: issues of power, positionality and "race" *Qualitative Methodologies for Geographers*. M. Limb and C. Dwyer. London: Arnold: 87-100.

Slovic, P. (1992). Perception of risk: reflections on the psychometric paradigm. *Social Theories of Risk*. S. Krimsky and D. Golding. Westport, Conn.: Greenwood: 117-152.

Slovic, P. (2000). Perception of Risk. *The Perception of Risk*. P. Slovic. London: Earthscan: 220-231.

Smith, F. M. (2005). Working in different cultures. *Key Methods in Geography*. N. J. Clifford and G. Valentine. London: Sage Publications: 179-193.

Smith, K. (2001) *Environmental Hazards*. London: Routledge.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (2007). Climate Change 2007: Working Group I: The Physical Science Basis. *IPCC Fourth Assessment Report: Climate Change 2007*. Cambridge: Cambridge University Press.

Spiker, E. C. and P. L. Gori (2000). National Landslide Hazards Mitigation Strategy: A Framework for Loss Reduction: USGS Open-File Report, 00-450.

Stallings, R. (1997). Sociological Theories and Disaster Studies. Retrieved 11/10/2005, from: http://www.udel.edu/DRC/preliminary/249.pdf.

Steedman, S. (1995). Megacities: The unacceptable risk of natural disasters. *Built environment* **21**(2-3): 89-93.

Stiller, L. (1973). *The Rise of the House of Gorkha*. Kathmandu: Ratna Pustak Bhandar.

Storey, D. (1997). Hey Joe! What are you doing?: Practicing participatory research in urban poor communities - lessons and experiences from the Philippines. *Working Paper 97/2* Palmerston North: Institute of Development Studies, Massey University.

Sudmeier-Rieux, K., R. A. Qureshi, P. Peduzzi, M. J. Jaboyedoff, A. Breguet, J. Dubois, R. Jaubert and M. A. Cheema (2007a). *An interdisciplinary approach to understanding landslides and risk management: a case study from earthquake-affected Kashmir*. Mountain Forum, Mountain GIS e-Conference, January 14-25 2008. Retrieved 20/12/2008, from: http://www.mtnforum.org/rs/ec/scfiles/Neelum_PK_landslides_2007.pdf

Sudmeier-Rieux, K., R. A. Qureshi, P. Peduzzi, J. Nessi, A. Breguet, J. M. Dubois, R. Jaubert, S. Rietbergen, R. Klaus and M. A. Cheema (2007b). Disaster risk, livelihoods and natural barriers, strengthening decision-making tools for disaster risk reduction, a case study from Northern Pakistan. *The World Conservation Union (IUCN) Pakistan Programme, Final Report*. Karachi: 53.

Susman, P., P. O'Keefe and B. Wisner (1983). Global disasters, a radical interpretation. *Interpretations of calamity from the viewpoint of human ecology*. K. Hewitt. London: Allen and Unwin: 263-283.

Swanson, K. (2008). Witches, children and Kiva-the-research-dog: striking problems encountered in the field. *Area* **40**(1): 55-64.

Tang, C., J. Zhu, W. L. Li and J. T. Liang (2009). Rainfall-triggered debris flows following the Wenchuan earthquake. *Bulletin of Engineering Geology and the Environment* **68**: 187-194.

Tearfund (2003). Natural Disaster Risk Reduction: The Policy and Practice of Selected Institutional Donors London: Tearfund.

Thapa, P. B. and M. R. Dhital (2000). Landslide and debris flows of 19-21 July 1993 in the Agra Khola Watershed of Central Nepal. *Journal of the Nepal Geological Society* **21**: 5-20.

Thompson, M. and M. Warburton (1985). Uncertainty on a Himalayan scale. *Mountain Research and Development* **5**(2): 115-35.

Thywissen, K. (2006). Core terminology of disaster reduction: a comparative glossary. *Measuring Vulnerability to Natural Hazards - Towards Disaster Resilient Societies*. J. Birkmann. Hong Kong: United Nations University Press: 448-496.

Tianchi, L. and J. Behrens (2002). An overview of Poverty, Vulnerability, and Disaster Management in Nepal. Kathmandu, Nepal: International Centre for Integrated Mountain Development Participatory Disaster Management Programme.

Torry, W. (1979a). Hazards, hazes and holes: A critique of *The Environment as Hazard* and general reflections on disaster research. *Canadian Geographer* **23**: 368-383.

Torry, W. I. (1979b). Anthropological studies in hazardous environments: past trends and new horizons. *Current Anthropology* **20**(3): 517-529.

Townsend, J. (1995). *Women's Voices from the Rainforest*. London: Routledge.

Tudhope, S. and M. Collins (2003). Global change: The past and future of El Nino. *Nature* **424**: 261-262.

Twigg, J. (1998). Understanding vulnerability - an introduction. *Understanding Vulnerability: South Asian Perspectives*. J. Twigg and M. R. Bhatt. London: Immediate Technology Publications Ltd.

Twigg, J. (2001). Sustainable livelihoods and vulnerability to disasters. *Disaster Management Working Paper 2*. London: Benfield Hazard Research Centre.

Twigg, J., C. Benson and M. Myers (2000). NGO initiatives in risk reduction: a summary of the research studies: British Red Cross, Disaster Mitigation Project.

Twigg, J. and D. Steiner (2002). Mainstreaming disaster mitigation: challenges to organisational learning in NGOs. *Development in Practice* **12**: 3-4.

Twyman, C., J. Morrisson and D. Sporton (1999). The final fifth: autobiography, reflexivity and interpretation in cross-cultural research. *Area* **31**: 313-326.

Uitto, J. I. (1998). The geography of disaster vulnerability in megacities - A theoretical framework. *Applied Geography* **18**(1): 7-16.

UN-ISDR (2002). Natural Disasters and Sustainable Development: Understanding the Links Between Development, Environment and Natural Disasters. Background Paper 5 of the Department of Economic and Social Affairs - Commission on Sustainable Development acting as the preparatory committee for the World Summit on Sustainable Development Second preparatory session 28 January - 8 February 2002. United Nations International Strategy for Disaster Reducation.

UN-ISDR (2004). Living with Risk - A Global Review of Disaster Reduction Initiatives: Retrieved 26/03/2006, from: www.unisdr.org.

UN-ISDR (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. World Conference on Disaster Reduction 18-22 January 2005, Kobe, Hyogo, Japan. Retrieved 12/06/2006, from: www.unisdr.org/wcdr.

UN-ISDR (2008). Indigenous Knowledge for Disaster Risk Reduction. Good Practices and Lessons Learned. Bangkok: UN-ISDR, Kyoto University and the European Union. Retrieved 08/05/2007, from:
http://www.unisdr.org/eng/about_isdr/isdr-publications/19-Indigenous_Knowledge-DRR/Indigenous_Knowledge-DRR.pdf.

UN Statistics Division. (2009). "Social Indicators - Indicators on Human Settlements." Retrieved 16/09/2009, from:
http://unstats.un.org/unsd/Demographic/Products/socind/hum-sets.htm.

UNDP (2007). Human Development Report 2007/2008. Fighting Climate Change: Human Solidarity in a Divided World. New York: United Nations Development Programme.

UNDP Nepal (2008). National Strategy for Disaster Risk Management in Nepal. Kathmandu: In association with the Government of Nepal, The European Commission of Humanitarian Aid and the National Society for Earthquake Technology: 96.

UNEP/OCHA. (2004). "Hurricanes Ivan and Jeanne in Haiti, Grenada and the Dominican Republic – A Rapid Environmental Impact Assessment." Retrieved 26/01/2005, from:
http://ochaonline.un.org/GetBin.asp?DocID=2173.

USGS. (2004). "Landslide types and processes." *United States Geological Survey Factsheet* Retrieved 15/12/2004, from: http://pubs.usgs.gov/fs/2004/3072/FS2004-3072.pdf.

Valentine, G. (1997). Tell me...using interviews as a research methodology *Methods in Human Geography*. R. Flowerdew and D. Martin. Harlow, Essex: Pearson Education Ltd.

Varley, A. (1994). The exceptional and the everyday: Vulnerability in the International Decade for Natural Disaster Reduction. *Disasters, Development and Environment*. A. Varley. Chichester: John Wiley and Sons: 1-11.

Varnes, D. J. (1978). Slope movement types and processes. *Landslides, Analysis and Control*. R. L. Schuster and R. J. Krizek. Washington D.C.: Transportation Research Board, National Research Council: 12-33.

Velasquez, G. and R. Ma T Tanhueco (2005). Incorporating Social Issues in Disaster Risk Assessment. *Know Risk*. United Nations International Strategy for Disaster Reduction. Geneva: Tudor Rose: 91-92.

von Furer-Haimendorf, C. (1975). *Himalayan Traders*. London: Cox and Wyman Ltd.

Wade, R. (1987). The management of common property resources: collective action as an alternative to privatization or state regulation *Cambridge Journal of Economics* **11**: 95-106.

Wadell, E. (1977). The hazards of scientism: a review article. *Human Ecology* **5**(1): 69-76.

Walker, G., P. Simmons, A. Irwin and B. Wynne (1998). Public Perceptions of Risks Associated with Major Accident Hazards. *CPR194/1998*. London: Health and Safety Executive.

Wang, F., Q. Cheng, L. Highland, M. Masakatsu, H. Wang and C. Yan (2009). Preliminary investigation of some large landslides triggered by the 2008 Wenchuan earthquake, Sichuan Province, China. *Landslides* **6**: 47-64.

Watts, M. (1983). On the poverty of theory. *Interpretations of Calamity*. K. Hewitt. London: Allen and Unwin: 231-262.

Watts, M. (1987). Drought, environment and food security: some reflections on peasant, pastoralists and commoditization in dryland West Africa. *Drought and Hunger in Africa*. M. Glantz. Cambridge: Cambridge University Press: 171-211.

Webster, P. J., G. J. Holland, J. A. Curry and H.-R. Chang (2005). Changes in tropical cyclone number, duration, and intensity in a warming environment. *Science* **309**: 1844-1846.

WECS (2005). National Water Plan (2002-2027). Kathmandu: His Majesty's Government of Nepal, Water and Energy Commission Secretariat.

WeD. (2006). "Toolbox: Community Profiles." Retrieved 07/06/2006, from: http://www.bath.ac.uk/econ-dev/welldev-esrc/research/methods-toobox/com-prof-toolbox.htm.

Westgate, K. N. and P. O'Keefe (1976). Some Definitions of Disaster: Disaster Research Unit Occassional Paper No. 4. Department of Geography, University of Bradford.

Whelpton, J. (2005). *A History of Nepal*. Cambridge: Cambridge University Press.

White, P. G., M. Fort and B. L. Shrestha (1987). Prototype 1:50 000 scale mountain hazard mapping in Nepal. *Journal of the Nepal Geological Society* **4**(1-2): 43-53.

WHO. (2004). "Cause of death and burden of disease estimates by country 2002." Retrieved 16/01/2007, from: http://www.who.int/healthinfo/statistics/bodgbddeathdalyestimates.xls.

Wieczorek, G. F. (1996). Landslide triggering mechanisms *Landslides: Investigation and Mitigation. Special Report 247.* A. K. Turner and R. L. Schuster. Washington D.C.: Transportation Research Board, National Research Council.

Williams, C. and C. E. Dunn (2003). GIS in participatory research: assessing the impact of landmines on communities in north-west Cambodia. *Transactions in GIS* **7**(3): 393-410.

Wisner, B. (2001). Risk and the neo-liberal state: why post-Mitch lessons didn't reduce El Salvador's Earthquake losses. *Disasters* **25**(3): 251-268.

Wisner, B. (2004). Assessment of capability and vulnerability. *Mapping Vulnerability*. G. Bankoff, G. Frerks and D. Hilhorst. London: Earthscan: 183-193.

Wisner, B. (2006). Self-assessment of coping capacity: Participatory, proactive and qualitative engagement of communities in their own risk management. *Measuring Vulnerability to Natural Hazards - Towards Disaster Resilient Societies*. J. Birkmann. Hong Kong: United Nations University Press: 316-328.

Wisner, B., P. Blaikie, T. Cannon and I. Davies (2004). *At Risk - Natural Hazards, People's Vulnerability and Disasters*. London: Routledge.

Wisner, B., P. O'Keefe and K. Westgate (1977). Global systems and local disasters: the untapped power of people's science. *Disasters* **1**(1): 47-57.

Wobus, C., A. Heimsath, K. Whipple and K. Hodges (2005). Active out-of-sequence thrust faulting in the central Nepalese Himalaya. *Nature* **434**: 1008-1011.

World Bank (1998). Indigenous Knowledge for Development: A Framework for Development: Knowledge and Learning Centre, Africa Region, World Bank. Retrieved 13/07/2007, from: http://www.worldbank.org/afr/ik/ikrept.pdf

Wynne, B. (1992). Misunderstood misunderstanding: social identities and public uptake of science. *Public Understanding of Science* **1**: 281-304.

Wynne, B. (1992). Uncertainty and environmental learning: reconceiving science and policy in the preventative paradigm. *Global Environmental Change* **2**(2): 111-127.

Wynne, B., C. Waterton and R. Grove-White (1993). Public Perceptions and the Nuclear Industry in West Cumbria. Lancaster: Centre for the Study of Environmental Change, Lancaster University.

Yin, Y. P., F. W. Wang and P. Sun (2009). Landslide hazards triggered by the 2008 Wenchuan earthquake, Sichuan, China. *Landslides* **6**(2): 139-152.

Zhao, W., K. D. Nelson and & Project INDEPTH Team (1993). Deep seismic reflection evidence for continental underthrusting beneath southern Tibet. *Nature* **366**: 557-559.

Zhou, T., R. Yu, H. Li and B. Wang (2008). Ocean forcing to changes in global monsoon precipitation over the recent half-century. *Journal of Climate* **21**(15): 3833-3852.

Zimmerman, M., M. Bichsel and H. Keinholz (1986). Mountain hazards mapping in the Khumbu Himal, Nepal. *Mountain Research and Development* **6**: 29-40.

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ORIGINAL PAPER

Trends in landslide occurrence in Nepal

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Abstract Nepal is a mountainous, less developed kingdom that straddles the boundary between the Indian and Himalayan tectonic plates. In Nepal, landslides represent a major constraint on development, causing high levels of economic loss and substantial numbers of fatalities each year. There is a general consensus that the impacts of landslides in countries such as Nepal are increasing with time, but until now there has been little or no quantitative data to support this view, or to explain the causes of the increases. In this paper, a database of landslide fatalities in Nepal has been compiled and analysed for the period 1978–2005. The database suggests that there is a high level of variability in the occurrence of landslides from year to year, but that the overall trend is upward. Analyses of the trends in the data suggest that there is a cyclicity in the occurrence of landslide fatalities that strongly mirrors the cyclicity observed in the SW (summer) monsoon in South Asia. Perhaps surprisingly the relationship is inverse, but this is explained through an inverse relationship between monsoon strength and the amount of precipitation in the Hill District areas of Nepal. It is also clear that in recent years the number of fatalities has increased dramatically over and above the effects of the monsoon cycle. Three explanations are explored for this: land-use change, the effects of the ongoing civil war in Nepal, and road building. It is concluded that a major component of the generally upward trend in landslide impact probably results from the rural road-building programme, and its attendant changes to physical and natural systems.

Keywords Landslide · Vulnerability · Monsoon · Precipitation · Roads

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1 Introduction

In recent years it has become apparent that landslides represent a far greater hazard globally than had been previously assumed, both in terms of economic losses and fatalities (Petley et al. 2005a; Petley 2006). It is also now clear that the impact of landslides, certainly in terms of both economic losses and probably also with respect to deaths, is increasing with time (Brabb 1991; Alexander 1993; Guzzetti 2000; Schuster and Highland 2001; Petley et al. 2005a). The majority of fatalities and the highest costs from landslides in terms of proportion of GDP occur in less economically developed areas, particularly in the tectonically-active monsoonal and tropical cyclone affected areas of Asia and the Americas (Petley et al. 2005a). In terms of absolute economic losses the highest impacts are probably in mountainous, more developed countries with high levels of rainfall and/or seismicity, notably Canada, the United States, Japan and Italy (Brabb 1991). Indeed, in many mountain environments, landslides represent one of the most acute hazards, although in general their impact is seriously under-represented (Hewitt 1997).

Unfortunately, the causes of the increases in the occurrence and impacts of landslides are poorly quantified. A wide range of hypotheses have been proposed, many of which are generally accepted even though there is little empirical evidence to support them. These include:

1. Population growth (for example Alexander 1993; Alexander 2005). Population growth is considered to influence the impact of landslides first by ensuring that there are more individuals at risk and second by driving the development of increasingly marginal terrain, most notably landslide prone areas at the toe of slopes and on steep mountainsides;
2. Land-use change, most notably deforestation (see for example Schuster and Highland 2001; Alexander 2005). The loss of forests is thought to reduce the rate of evapotranspiration on slopes, leading to higher groundwater levels, to reduce cohesion through the loss of root strength and to increase overland flow, which enhances the rate of erosion (Crozier 2005). The effect of these changes is to render slopes increasingly sensitive to landslide triggers and to increase the mobility (i.e., the run-out velocity and hence distance) of slides once they have been initiated.
3. Urbanisation. The growth of cities, especially in less economically developed countries, leads to the growth of urban slums or shanty-towns on marginally stable slopes on the periphery of urban areas (Schuster and Highland 2001; Alexander 2005 for example).
4. Linear infrastructure development. The construction of transport infrastructure, especially roads, is considered to increase the probability of landslides as a result of undercutting and the application of surcharges as a result of the disposal of spoil and through the relocation of people who wish to take advantage of the economic opportunities associated with roadside sites (for example Sidle et al. 2006). Unfortunately, such sites are often more susceptible to landslides than are the locations of their original houses.
5. The effects of (anthropogenic) climate change, which might be changing rainfall distributions and intensities (Petley et al. 2005a).

Unfortunately, the actual impact of these changes in real terms is poorly quantified, such that in many cases these effects, although logical, are little more than anecdotal. Understanding these processes is undoubtedly important given the global cost of landslides. In addition, heavy investment is being made in mountainous areas of less economically-developed countries by a range of international organisations, including international development agencies such as the Inter-American Development Bank, the World Bank and the Asian Development Bank and national development agencies such as DFID (UK), JICA (Japan), Helvetas (Switzerland) and GTZ (Germany). In many cases this investment is focussed upon the development of rural access, for which the occurrence of landslides is a key issue. There is clearly an urgent need to try to quantify changes in the occurrence and impacts of landslides, and to develop an understanding of the causes of these changes through time. This understanding will help to target scarce resources in the most appropriate manner, and to improve the identification of areas and individuals at risk from the effects of landslides.

The aim of the study reported here is to compile and evaluate data regarding the temporal trends in landslide occurrence in Nepal in the period 1978–2005 and to use these data to attempt to understand the underlying causes of changes in landslide impacts through time. To do this, we have constructed a database of fatal landslides for the study period. This database has been analysed in terms of spatial and temporal distributions, with a particular emphasis upon the relationships with the distributions in time and space of potential triggering factors.

2 The study area

Nepal is a mountainous Himalayan kingdom with a surface area of 147,181 km^2 (Fig. 1). Globally, it is the country with the highest relative relief on earth, with

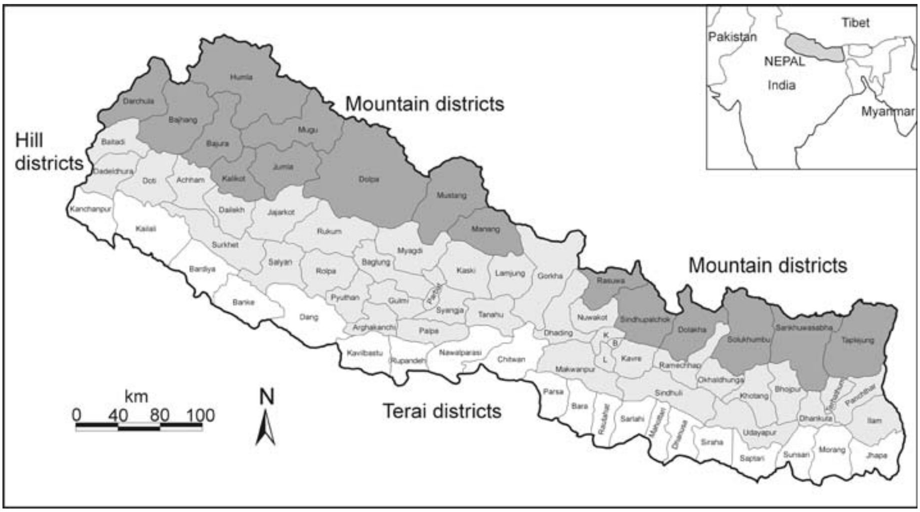

Fig. 1 A map of Nepal showing the subdivision of the country into Mountain, Hill and Terai districts. Inset is a thumbnail map showing the location of Nepal within South Asia

a lowest elevation of 70 m above sea level and a maximum elevation at the summit of Sagamartha (Mount Everest) of 8848 m. For management and development purposes the terrain of Nepal can be divided into three regions (Fig. 1). In the south of the country lie the Terai districts, representing 23.1% of the surface area of the country, whose topography mostly consists of flat alluvial plains. These districts have comparatively high population densities (48.5% of the total population of Nepal). In the far north lie the mountain districts, incorporating the remote mountain massifs of the High Himalaya, which comprise 35.2% of the land area of Nepal. These areas are however sparsely inhabited, supporting only 7.3% of the population. Between these two areas lie the Hill Districts of the Middle Himalaya, within which much of the terrain consists of alpine-height mountains and valleys (i.e., peaks reaching up to ca. 5000 m but valleys at less than 500 m asl). The population of this area, which includes the Kathmandu Valley, represents 44.2% of the national total.

As would be expected for a country with such an extreme range of elevations, the climate varies greatly, ranging from subtropical on the lowland plains to glacial in the high mountains. The climate throughout most of the country is strongly monsoonal. For the landslide-prone Middle Himalayan terrain the climate is cool and dry for much of the year, although the summer months (June-September) are warm and humid, with high levels of precipitation associated with the south-west Asian monsoon. The actual levels of rainfall during the monsoon period vary considerably from year to year, depending upon a range of climatic factors that are generally-considered to be associated with global and regional climatic systems (Shrestha et al. 2000).

It is well recognised that landslides occur extensively in the Himalayas (e.g., Owen et al. 1995; Sah and Mazari 1998; Barnard et al. 2001; Sarkar et al. 1995), and in particular within Nepal (e.g., Gardner and Gerrard 2000a; Petley et al. 2005b). An area such as the Himalayas should be expected to have a high level of natural landslide activity. In tectonically active mountain chains such as the Himalayas, natural landslides play a fundamental role in the evolution of the landscape, providing a mechanism through which a mass balance can be achieved between uplift and erosion. Landslides represent the most efficient process in non-glaciated (and possibly also in glaciated) environments through which material that has been advected into a mountain chain by tectonic processes can be released from the hillsides and removed. Thus, it is a mistake to consider that all landslides are the result of human activities, or that all landslide risk is socially "constructed". However, there is a clear anthropogenic influence in the occurrence of landslides in the mountainous areas of Nepal (see for example Gerrard and Gardner 2000a, b; 2002). Note though that except along road corridors most of the documented human-induced landslides are in reality comparatively small and shallow. Nonetheless human-induced landslides often have a substantial impact, especially in terms of loss of local agricultural productivity, which can have severe economic effects both locally and nationally. For example, the large failure at Krishnabhir in Dhading District, southwest of Kathmandu, led to the closure of the key arterial road linking Kathmandu with the Terai plains and thus with India for eleven days in August 2000, causing serious economic disruption to the capital city.

3 Methodology

For this study we have compiled a database of landslide fatalities for Nepal for the period 1978–2005 inclusive. This database was constructed using a variety of sources, including newspaper reports, government datasets, NGO documents, scientific papers and, where reliable, personal accounts. Sources of information were predominantly in the Nepali language, but English language information sources were also used when available. The most consistently available data for a landslide events provides the date of occurrence, location, trigger mechanism (i.e., heavy rain or construction for example), number of fatalities, number of injuries and the number of people missing. Less consistently reported, but recorded when available, were information on the type of landslide, size, rate of movement, damage to infrastructure and property, loss of farm animals and direct economic damage. In this analysis we have focussed upon temporal and spatial trends in the number of landslide fatalities each year, as these data are generally consistent throughout the dataset.

Considerable complexities and problems are associated with the construction of such databases. Critical amongst these are the following:

1. *Definitions of landslide*. There is a key need to think about how the term ‘‘landslide’’ is defined. There are two elements to this: first, technically there is a need to decide which events to include within the database. Thus, for example should a debris flow be included? If so, how can a differentiation be made between a debris flow and a hyper-concentrated flow? Second, how accurately do the reports used to compile the database achieve this differentiation? Hence, debris flows are very often reported as floods; whilst flash floods are often reported as mudflows. Clearly this problem can never be solved fully. We have addressed this issue by seeking to include events that would fall under the well-established landslide classification of Cruden and Varnes (1996), which includes debris flows, mudflows and rock falls. In each case the compilers of the database had to make a judgement as to whether the event should be classified as a landslide, using the available reports and, where possible, images of the event.
2. *Definitions of fatalities*. Although in a sense the definition of a fatality might seem straightforward, in the context of a database such as this, it is actually somewhat problematic. First, there is a need to determine whether a death is actually caused by a landslide. This is simple in the case of burial by the landslide or impact from a rock fall. However, should a death that results from a car impacting landslide debris be included? If so, what about the case in which a car is forced to swerve to avoid landslide debris, and ends up driving into the river? Finally, what about the case in which a road is closed by a landslide? As a result vehicular traffic might be forced onto a lower quality road, leading to an enhanced accident rate. Consistency is difficult to achieve in such cases due to the complexity of the natural and social environment. As a general rule, we have worked on the basis that there must be a connection either in a physical sense between the landslide and the individual (i.e., deaths resulting from a car impacting the debris would be included) or in time (so fatalities resulting from a car swerving to avoid a landslide as it impacts a highway would be included, but a car swerving off the road to avoid the debris pile in the following days would not). Clearly the distinction is arbitrary, but is nonetheless necessary. In general, the numbers of fatalities associated with such complex cases is low in comparison with the overall total, meaning that the impact of these concerns is not unduly high.
3. *Secondary hazards*. The issue of the inclusion of secondary hazards is problematic for all database studies. Landslides themselves are often considered to be a secondary hazard associated with storms and earthquakes, which has

resulted in the gross under-reporting of landslide impacts (see Petley et al. 2005a for a review of this topic). However, landslides themselves are also associated with secondary hazards, most notably dam break floods resulting from valley blocking episodes (Costa and Schuster 1991; Dunning et al. 2006). In this study we have sought to include the deaths associated with such secondary hazards within the database where the secondary hazard is naturally occurring (for example, a dam break event). In databases documenting multiple hazard types this can lead to concerns regarding double counting, but this is not a problem when a single hazard type is being studied, as in this study.

4. *Reliability*. Perhaps the greatest concern regards issues of the reliability of the data included in the database. A number of problems arise here:

    a. *Exaggeration and under-estimation*. It is well-established that in large disaster events there is a tendency for local officials and government bodies to exaggerate the death toll (Hittelman et al. 2001 for example). In many cases this is due to double counting of potential victims, or to the inclusion within the list of victims of people who in reality were not in the area. At times it has also been associated with a desire to increase the provision of assistance and/or with corruption. Occasionally, under-estimation may occur, for example where pressures are exerted in order to avoid political embarrassment. Generally, this latter problem is most acute for large events. Additionally, in many cases the death toll includes a number of people who are listed as ‘‘missing’’. In many cases it is not established how many people in this category have actually died, and there are a range of ways in which final estimates can be derived.
    b. *Post-event mortality.* A further problem lies with the occurrence of deaths days or even weeks after a landslide event. In most cases there is little or no information available as to whether people who are wounded by a landslide eventually succumb to their injuries. Thus, it is reasonable to assume that as a certain proportion of such people do die, the figures within the database are a slight underestimate of the total number of fatalities. Theoretically, it might be possible to apply a correction factor to deal with this issue (perhaps assuming that say 25% of those injured eventually die from their injuries). However, we have no data on what this factor should be in Nepal, so no correction has been applied in this study.
    c. *Small event mortality.* A further problem lies in the inclusion of all events in the study area. In particular, small events with limited numbers of fatalities are often poorly reported, especially where they occur in an area with poor communication infrastructure. It must therefore be accepted that we fail to resolve many of these events, which in some cases might consist of a single piece of rock striking an individual. This lack of resolution is akin to the resolution problem observed when constructing landslide databases from aerial photographs (Stark and Hovius 2001 for example), and it might thus be expected that a similar ‘‘roll-over’’ in the power law frequency distribution of event sizes will be observed. We accept this limitation of our data, but believe that the impact is not as serious as might be feared, as Petley et al. (2005a) demonstrated that for landslides it is the larger events that dominate the fatality statistics.

It could be argued that these limitations mean that the construction and analysis of such a database is questionable. We do not believe that this is the case. In most cases the errors are comparatively small relative to the total number of events and the errors are essentially consistent spatially and temporally through the dataset. At all times these errors must be considered when interpreting the dataset, and we suggest that in general the numbers cited here should be considered to be an underestimate of the total impact of landslides within Nepal.

4 The Nepal landslide dataset

In the complete dataset for the period 1978–2005, we have recorded a total of 397 fatal landslides in Nepal, which caused 2179 recorded fatalities, representing an average of about 78 deaths per year. Analysis of these annual data (Fig. 2) shows that the number of fatalities varies greatly from year to year. The smallest number of deaths occurred in 1981, when only five fatalities were recorded, whereas the largest number was 342 in 2002. A similar variation is noted in the number of fatal landslides per year, which ranges from one in 1981 to 58 in 2002. There appear to be some interesting underlying trends in the data, with distinct periods when the number of fatal landslides and the number of fatalities increase (1982–1989 and 1997–2005) and periods when the numbers are substantially lower (1978–1981 and 1990–1996). It is also notable that there appears to be a general increasing trend, with the five most deadly years all occurring in the period 1998–2005. Note however that this is not a simple upward trend, as a peak in fatalities and numbers of landslides occurred in the period 2001–2003, and a decline is noted thereafter.

A simple examination of the temporal occurrence of fatal landslides reveals the strong climatic control on the triggering of instability (Fig. 3). There are no recorded landslide fatalities in the period from November to April, reflecting the very dry conditions in Nepal during this part of the year. A small number of events have been recorded for May, with a further increase in June. Interestingly, there is a marked

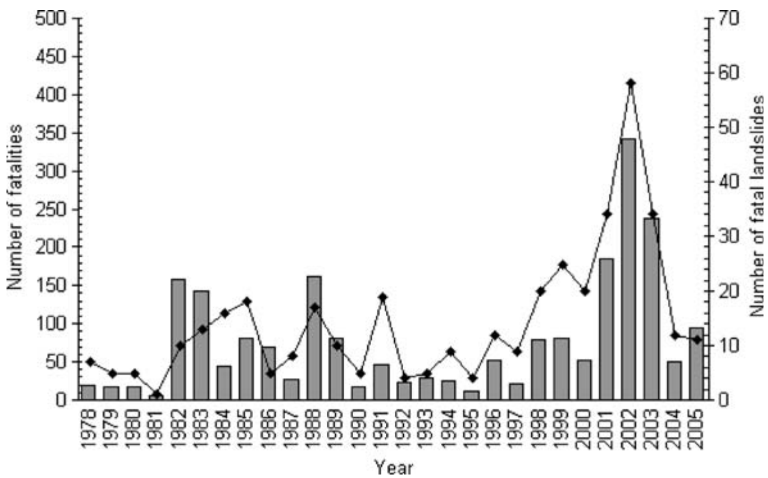

Fig. 2 Graph showing the number of landslide fatalities (bar graph, left hand scale) and the number of fatal landslides (line graph, right hand scale) each year for the period 1978–2005 for Nepal

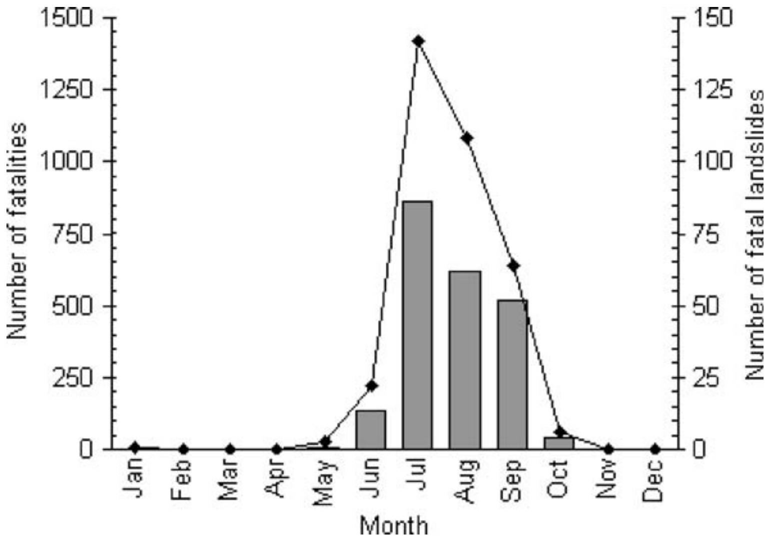

Fig. 3 Graph showing the occurrence of landslide fatalities (bar graph, left hand scale) and the number of fatal landslides (line graph, right hand scale) by month for the period 1978–2005 for Nepal

peak in landslide occurrence in July, with slightly lower but still notable totals in August and September. The number of landslides declines to a very low number in October, and to zero in November. This very strong seasonality reflects the occurrence of rain associated with the South Asian Summer Monsoon, which in Nepal has a modal start date of 10 June, peaks in terms of rainfall intensity in July and continues to a modal date of 21 September (Hannah et al. 2005). This main monsoon period is characterised by a moisture-laden air mass that moves progressively northwards from the Bay of Bengal. The pre-monsoonal period extends from March to May, and is characterised by warm, dry weather with limited rainfall. The post-monsoon period (October to November) is dry and warm, with November being the driest month on average. Finally, the winter period (December to February) is generally dry and cool. Thus, it is clear that the annual occurrence of landslides depends heavily upon the summer monsoon. Interestingly however, although the monsoon period represents 60–80% of the annual total precipitation, and 55–80% of runoff (Shrestha et al. 2000), it accounts for 92% of landslide fatalities and 90% of the fatal landslides.

The distribution of fatal landslides across Nepal is very uneven (Fig. 4A). In general, the density of fatal landslides is low for the Terai districts and for the mountain districts in the northwest of the country (Fig. 1). The density is highest for the hill districts, especially in the central and eastern parts of the country. There is also an area of higher density in the hill districts in the west of Nepal. This distribution appears to be determined primarily by a combination of relief and precipitation. The Terai districts mostly comprise flat plains, upon which landslides are not common. In the hill and mountain districts the distribution reflects reasonably well the distribution of annual precipitation totals, for which the highest levels are in the hill districts, especially in central and eastern Nepal (Fig. 4B).

Many authors have suggested that the frequency–area relationship for medium and large landslides can be described by an inverse power law relationship (Hovius

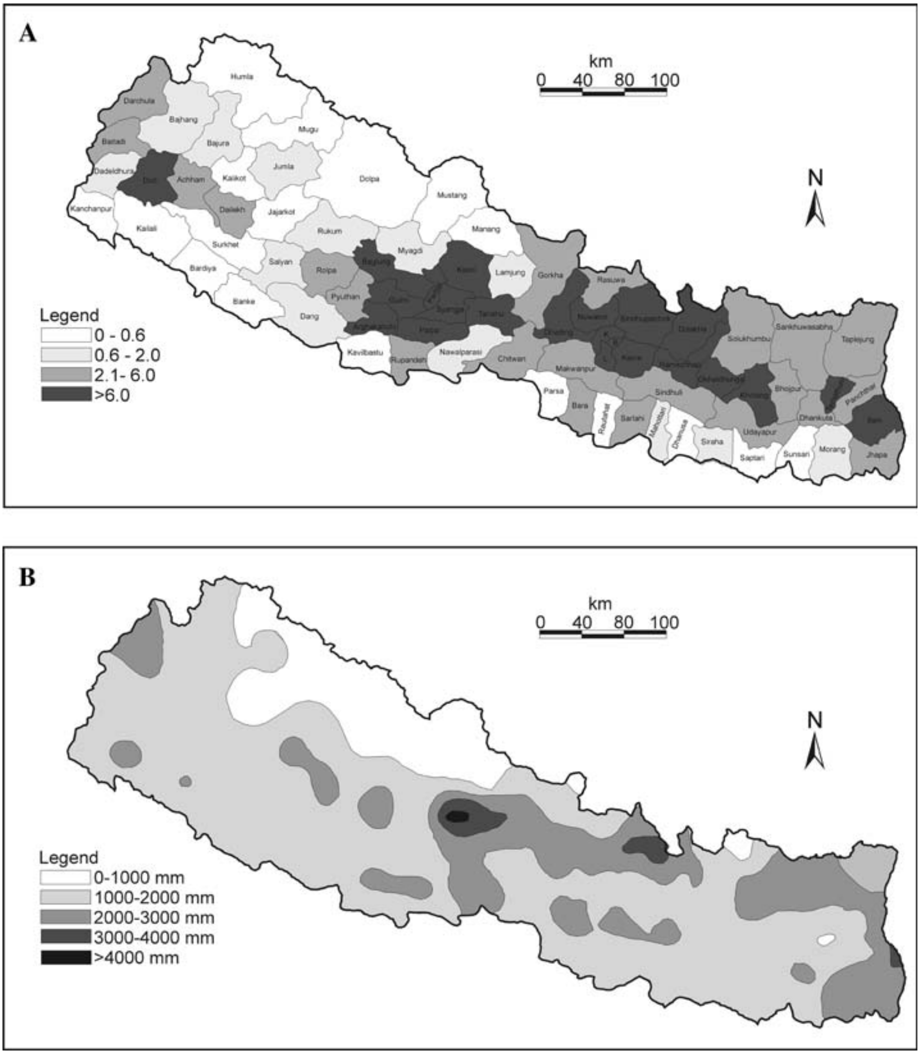

Fig. 4 (**A**) The distribution of fatal landslides by district for Nepal. The data are given as the recorded number of fatal landslides per 10^3 km^2 for the period 1978–2005. (**B**) The corresponding annual precipitation variability (data from Chalise et al. 1996)

et al. 1997, 2000; Dussauge et al. 2003; Malamud et al. 2004). This relationship appears to hold despite large variations in landslide type, size, and triggering mechanism (Malamud et al. 2004). We have undertaken this type of analysis for the landslide fatality dataset, in which we use fatalities as the indicator of landslide size. For events with higher numbers of fatalities a power law "tail" is present (Fig. 5), although note that this is across just three orders of magnitude of size, whereas the more commonly analysed power law frequency–landslide area relationships extend over five or even six orders of magnitude (Turcotte 1999). This reduced size power law tail is probably due to a limitation of the current dataset given the constraints on the measure of landslide size using fatality data. It is likely that a larger dataset

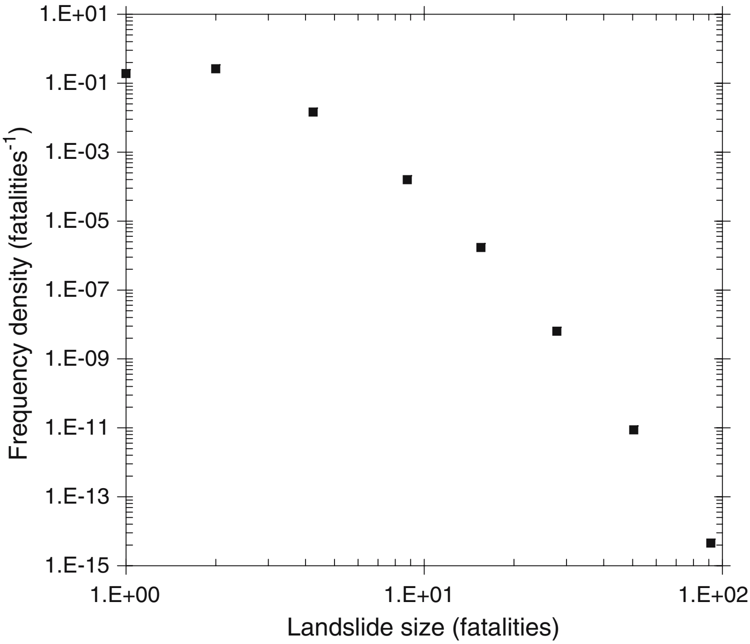

Fig. 5 The Nepal landslide dataset plotted as a probability density function

would show the same pattern over a greater number of orders of magnitude. For smaller events (i.e., those with ten or less fatalities) a ‘‘roll-over’’ is apparent in which the power law no longer applies, as seen in frequency-area data of Malamud et al. (2004). Such roll-overs have been considered to be more than just an artefact of data collection, representing a real characteristic of landslides (Malamud et al. 2004). However, Stark and Hovius (2001) suggested that at least in part it might be the result of under-sampling of smaller events due to problems associated with mapping resolution. In the case of the landslide database we consider that it is likely that this roll-over is also a real attribute of the landslide distribution. However, it may also be that there is significant under-sampling of the dataset as it is most likely that the smallest landslides, which might kill only one or two people, might not be reported, especially in rural areas. The largest landslides on the other hand are much more likely to be documented, and thus to appear in the dataset. What is clear is that for Nepal landslide fatalities show the same general frequency–magnitude relationship as for the landslide sizes themselves.

5 Causation in the temporal variation of landslide fatalities in Nepal

Clearly there is considerable variation in the temporal occurrence of landslides in Nepal, with an apparent underlying cyclicity with time. Here we seek to examine these trends and to attempt to account for them. To do this we use the running mean technique common in hydrology and climatology (Horii and Hanawa 2004 for example), based on a five–year kernel, in order to smooth both the climate and fatality data. This permits the analysis of trends in the dataset to be undertaken easily.

It is clear that the majority of fatal landslides in Nepal are triggered by monsoon rainfall. A number of indicators are commonly used to examine monsoon strength, based on either precipitation intensities or on atmospheric circulation. The most widely-used indicator of the former is the All India Monsoon Rainfall Index (AIMI), which is an areal average of 29 subdivisional rainfall datasets (Parthasarathy et al. 1995) based on total rainfall across 306 rainfall stations that span India, although it should be noted that few if any of these are located in the Himalayas. The index is based upon rainfall totals for June, July, August and September. AIMI data for the period 1978–2005 have been obtained from the Indian Institute of Tropical Meteorology.

The five year running mean of landslide fatalities shows the trends described previously, with comparative peaks in 1982–4 and 2001–3, and a trough in 1992–5 (Fig. 6). Notably, the peak in 2001–3 is substantially greater than in 1982–4. Broadly speaking, the AIMI shows the same trend, but in reciprocal form (Fig. 6). This comparatively weak but still significant, linear, inverse relationship is evident in regression (Fig. 7). In many ways this is counter-intuitive as it suggests that more fatalities occur in dry years than in wet ones. However, in a comparison of annual (rather than monsoonal) rainfall trends between Nepal and India for the period 1959–1994, Shrestha et al. (2000) noted that "*a comparison between precipitation fluctuations over Nepal and over India does not show good agreement*". This may suggest that the AIMI data are a poor indicator of monsoon strength for Nepal on account of the different spatial coverage. Indeed the same authors noted that:

> "the precipitation climatology in the northern part of the subcontinent (including the Himalayan region) is different from the rest of the subcontinent, and that the precipitation record from India as a whole (and generally excluding the Himalayan region) is not always a suitable representation for the region".

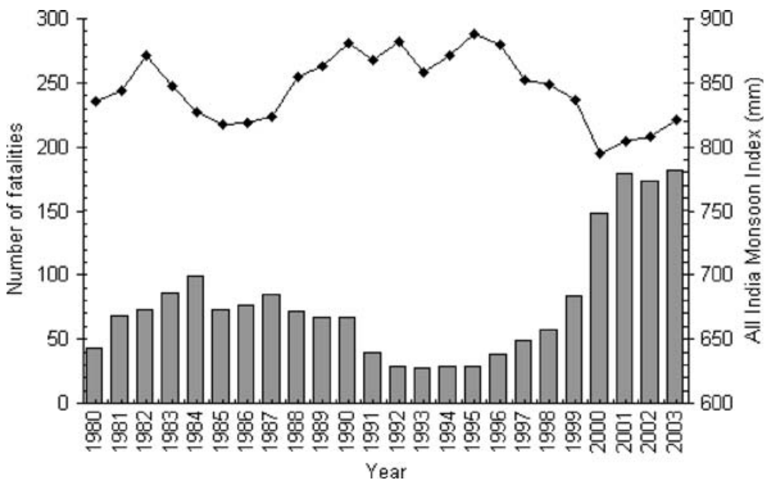

Fig. 6 Five-year running means, indicating medium term trends, for the number of fatalities per annum (bar graph, left axis) and AIMI (line graph, right axis)

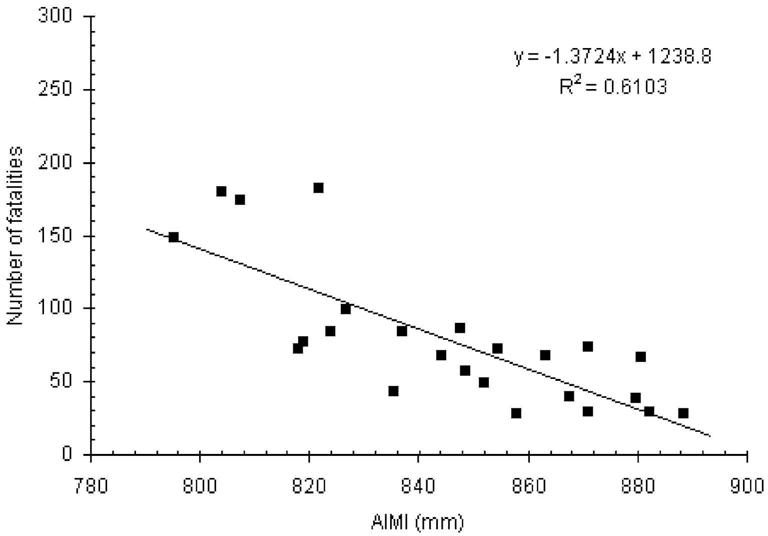

Fig. 7 Regression between the number of fatalities per year and AIMI, based on five-year running mean data

However, they did not observe an inverse relationship between monsoon precipitation in India and Nepal as our data might infer. Shrestha et al. (2000) did note that there is an eleven year periodicity in the Nepal annual precipitation record, which they related to sunspot cycles. The landslide data suggest a rather longer (ca. 14-year) periodicity, however.

An alternative index of monsoon strength is the new South Asian Summer Monsoon Index (SASMI) of Li and Zeng (2003). This index is based upon a dynamical normalized seasonality index of intensity of the wind field at the 850 hPa level. As such it is not an indicator of the intensity of monsoon precipitation, but nonetheless it provides an index of the strength of the atmospheric processes that are responsible for rainfall generation. As with the AIMI dataset, there appears to be an inverse relationship between the overall strength of the monsoon as indicated by smoothed SASMI data and the number of landslide fatalities (Fig. 8). Regression of the two datasets suggests that this is rather a complex relationship in reality, as the data appear to plot into two distinct groups (Fig. 9). During the period 1980–1994 there is a simple, but comparatively weak linear relationship between the numbers of landslide fatalities. From about 1995 the relationship appears to change, with a much larger number of fatalities for a given SASMI value. The relationship remains strongly linear. Thus, there appears to be a change in some way in the dynamic relationship between the number of fatal landslides and the SASMI. We return to this issue below.

The inverse relationship between the monsoon indices and the number of fatal landslides appears to be counter-intuitive. However, Shrestha et al. (2000) compiled an index of monsoon precipitation for Nepal for the period 1959–1994, broken down into the east and the west of the country, and the Terai, hill and mountain districts. We have aggregated the index for the hill districts east and west and compared this with the SASMI, using the running means for the period 1978–1994 (Fig. 10). This shows a strong, linear, negative relationship between the SASMI and the Hill Districts monsoon precipitation, which would appear to explain this anomaly. Thus,

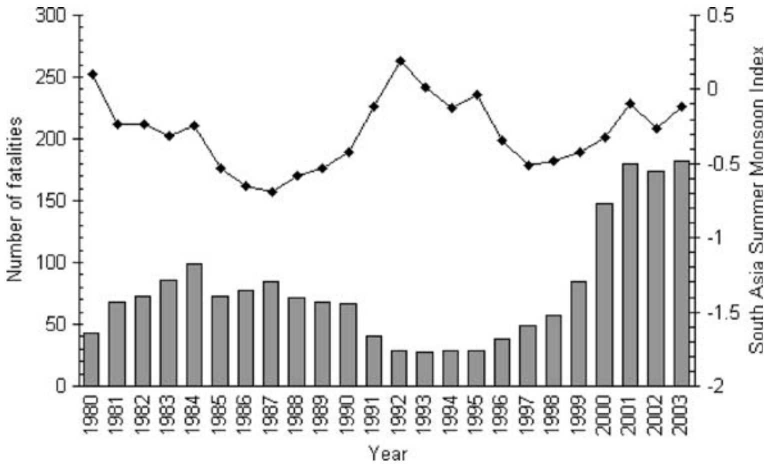

Fig. 8 Five-year running means, indicating medium term trends, for the number of fatalities per annum (bar graph, left axis) and the July SASMI (line graph, right axis)

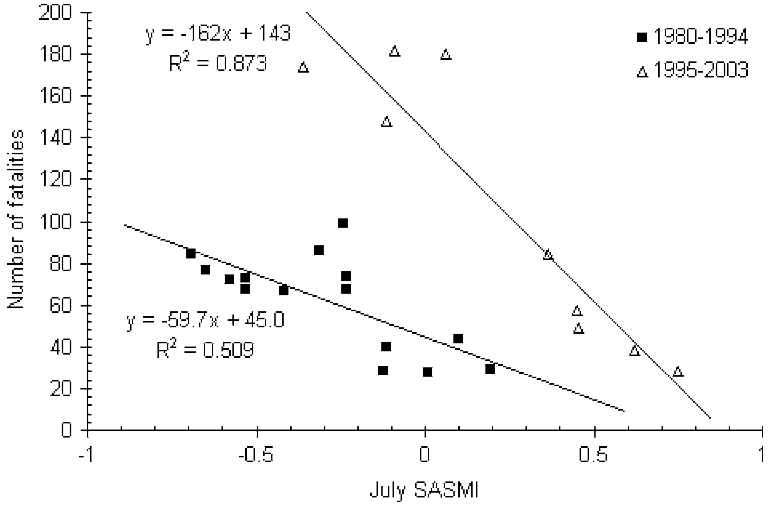

Fig. 9 Regression between the number of fatalities per year and the July SASMI, based on five-year running mean data. The data are divided into two populations, 1980–1994 and 1995–2003 as different relationships between appear to operate for the two sets

when the monsoon index is strongly positive, the total monsoon precipitation in the hill districts of Nepal is comparatively low and vice-versa. Thus, the inverse relationship between SASMI and the number of landslide fatalities is explicable, suggesting that a prediction of the likely value of SASMI would allow an indication of the intensity of landslides triggered by the monsoon. The net impact of precipitation is thus intuitive and logical. In years in which the monsoon indices are high and thus the monsoon is intense, the precipitation level reaching the Middle Hills region is low, and thus comparatively few landslides occur. On the other hand, in years when the monsoon indices indicate a weak monsoon, the level of precipitation is high in the Middle Hills region, and the occurrence of landslides is consequently high.

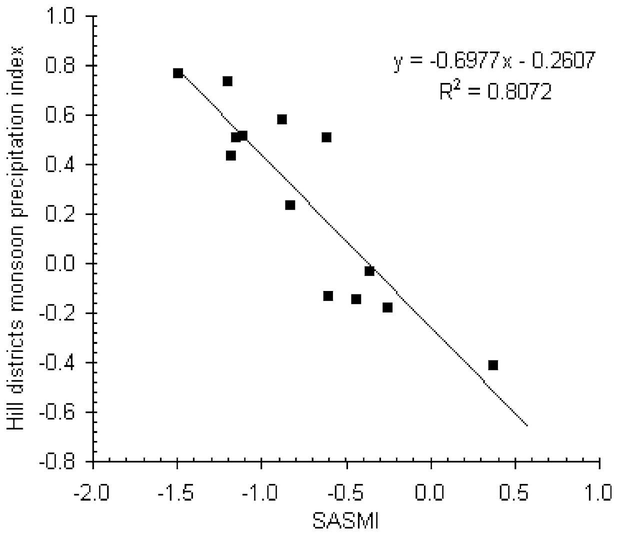

Fig. 10 Regression between the Hill districts monsoon precipitation index, as derived from Shrestha et al. 2000, and the SASMI for 1978–1994, showing a strong, linear, inverse relationship

Bookhagen et al. (2005) noted that the pattern of rainfall associated with the summer monsoon in the Himalayas is affected by both the regional scale atmospheric conditions and the more local scale effects of topography, most notably the interaction between the terrain and the wind distribution. The landslide dataset clearly supports this view.

The cause of the increased prevalence of landslide fatalities is of key importance to the management of the hazard in Nepal. Examination of the relationship between average landslide size and the SASMI indicates that there is a strong linear relationship (Fig. 11). It is notable that the average landslide size increases when the

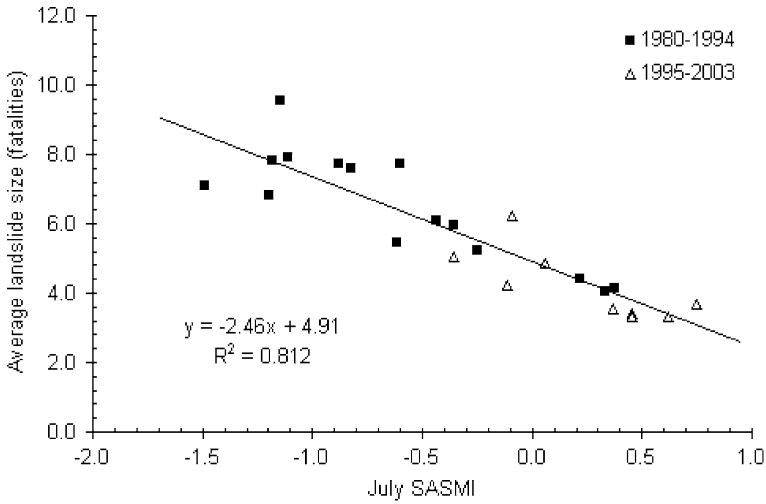

Fig. 11 Regression between the average size of the landslides, and the July SASMI, showing a strong, linear, inverse relationship

SASMI reduces, i.e. when the precipitation total increases. It is perhaps logical that larger rainfall events trigger greater numbers of large landslides. Interestingly however, this relationship is constant through time and does not show the large increase in recent years seen in the total number of fatalities. It is clear that change appears to be one of an increase in the number of fatal landslides occurring, each of which kills on average similar numbers to before, rather than there being the same number of fatal landslides, each of which is larger.

This would seem to imply that there is an increase in either the susceptibility of the landscape system to rainfall events—i.e., that each for a rainfall event of a given size more landslides occur; or a change in the vulnerability of people—i.e., the same number of landslides are occurring, but there are more people in the way of them. However, if the change was due to increased vulnerability due for example to increased population densities, then it is surprising that the average size of the events has not increased—it is logical that there would be more people in the path of each fatal landslide, which should increase the overall average. Thus, it seems likely that there is an increased number of landslides occurring in the landscape with time. It appears that the change in occurrence of landslides is dated from about 1995, after which quite an abrupt transition has been noted. We do not believe that this is solely the result of increased reporting of landslides as there is no logical reason why such an abrupt change should be noted at this time, and we would expect that increased reporting would lead to more of the smaller events being noted, i.e., the average size in terms of fatalities should decrease.

One logical explanation might be the effect of deforestation in Nepal. Deforestation is widely recognised as a significant cause of landslides in upland environments (Glade 2003 for example), and especially in Nepal (Gerrard and Gardner 2002). Rates of deforestation in Nepal are high, averaging 1.35% of the forest resource per annum in 2005 (FAO 2005) (Fig. 12A). However, the rate of deforestation peaked in the period 1985–1990 (Fig. 12A), and has declined subsequently. Thus, the more recent large increase in the occurrence of fatal landslides does not appear to coincide with the main phase of deforestation, although a lag effect and the role of a critical threshold in forest cover, at which point the occurrence of landslides increases dramatically, cannot be discounted. Indeed it is difficult to imagine that this level of deforestation is not a contributor to this substantially increased occurrence of fatal landslides.

A second potential explanation lies in the rapid development since about 1990 in the road network of Nepal (Fig. 12B). This results from a change in national and international priorities for the economic and social development of the country in which an emphasis has been placed on "access" for rural communities, with a key aspect of this being the construction of a new and extensive network of low technology rural roads. Thus, most of the roads built since 1990 have been gravel or earthen roads, constructed using the participatory approach (i.e., using local human and physical resources as much as possible) and with comparatively low levels of conventional engineering design input. The increased occurrence of landslides along new road corridors is very well documented (Sidle et al. 2006 for example). In addition, the construction of new roads may cause changes in the dynamics of local societies as economic activity restructures to take advantage of the new opportunities presented by the road. Thus, in many cases there is a relocation of the population to live beside the road, which might lead to increased vulnerability and

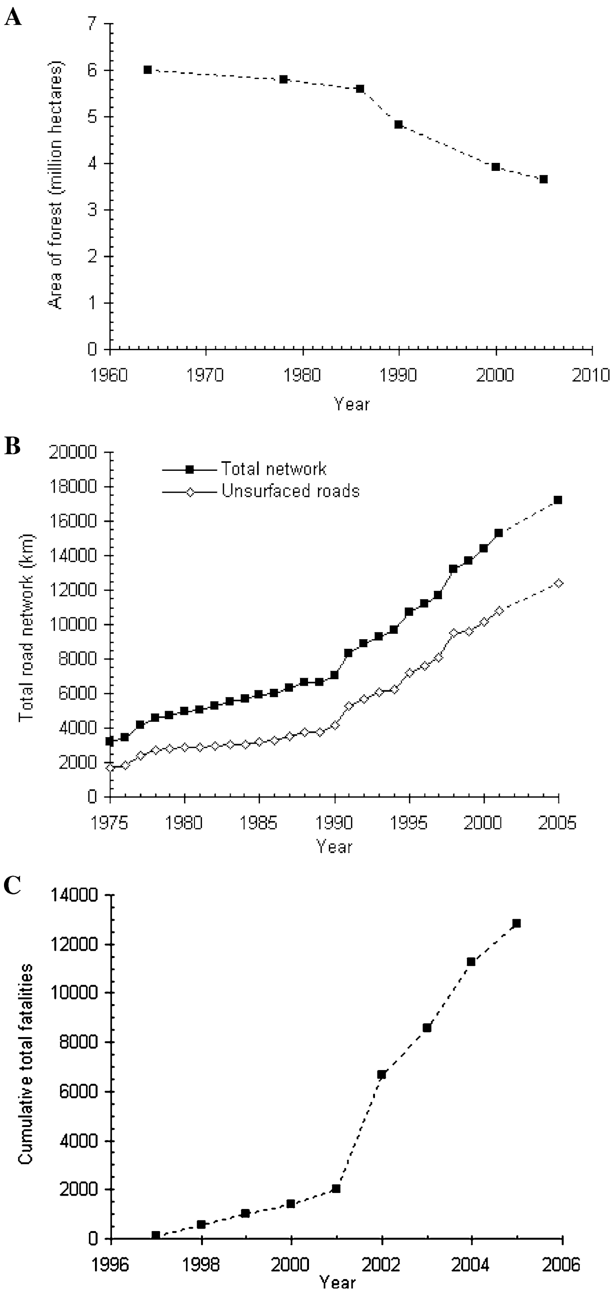

Fig. 12 Three possible trends causing the increased sensitivity of the landscape to landslides. (**A**) The effects of deforestation (after Govil 2000), (**B**) The growth of the road network in Nepal, illustrating the dramatic increase in the amount of road construction in the early part of the 1990's, (**C**) The number of fatalities per annum associated with the ongoing civil war

changes in land use, including in some cases the abandonment of the terrace cultivation systems. These changes might well lead to an increase in landslide impacts.

Finally, it is notable that the changes coincide with the initiation of the ongoing civil war in Nepal (Fig. 12C). It is possible that this destructive conflict is increasing vulnerability due to enhanced levels of poverty and the consequent migration of people from the Maoist controlled rural areas into the government controlled major

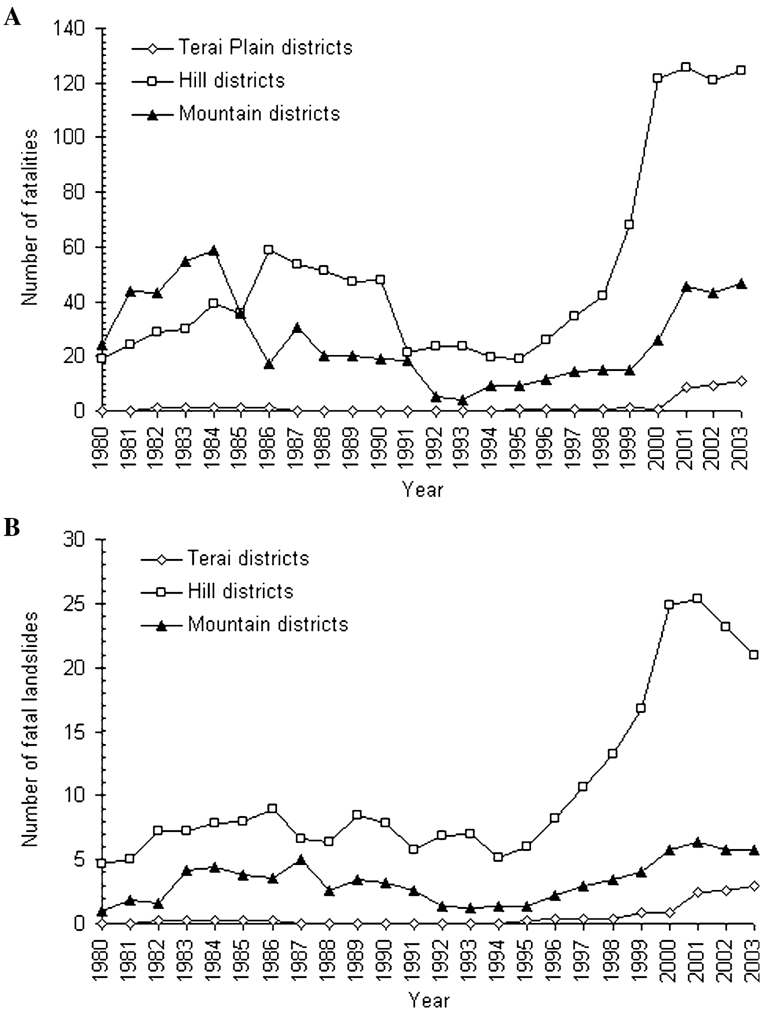

Fig. 13 Graph showing the change across the three main terrain areas of Nepal in (**A**) the number of landslide fatalities and (**B**) the number of fatal landslides per year. Both datasets have been smoothed using the five-year running mean

population centres, especially on the Terai plain. The growth of landslide-prone urban slums has been a consequence of this process in other countries (Barling 2001 for example), and so might also be significant in Nepal.

An insight into the role of these three processes is given by an analysis of the number of both fatalities (Fig. 13A) and fatal landslides (Fig. 13B) according to the three main terrain units. It is clear that there has been only a small increase in the number of both fatalities and fatal landslides in the Terai plain areas. Thus, it seems unlikely that the large increase in the number of fatal landslides is due to this population migration. Indeed, most of the changes have occurred in the hill districts. Interestingly, Joshi (1998) suggested that deforestation in the hill districts of Nepal, whilst not insignificant, has not increased in rate in the 1990's. Most of the deforestation during this time has occurred on the Terai plains. Thus, it does not appear likely that deforestation is the major cause of this increase in fatal landslide occurrence, although it is probably a small component. On the other hand, the hill districts have been the main focus of road building activity since the mid 1990s. Thus, the most likely explanation for the increase in landslide activity would seem to be the road construction programme, and the associated changes that this causes. Needless to say there is an urgent need to examine this in more detail.

6 Discussion

In this study we have examined the occurrence of fatal landslides in Nepal in the period 1978–2005 through the compilation of a database of fatal landslide events. Of course we fully recognise the deficiencies of such approach, as outlined at the start of the article. We recognise that the error levels in the data are quite large, and that in general the database probably underestimates the impact of landslides. There is undoubtedly one major additional error in the database. This is the result of a major flood and debris flow disaster that struck southern and central Nepal on 19th–22nd July 1993 as a result of an extreme rainfall (cloudburst) event. This event represents the largest non-seismically-induced disaster in the historic record for Nepal. About 70,000 people in total were affected by this disaster and the death toll exceeded 1,160 in the Bagmati, Kulekhani and Narayani basins. A proportion of these fatalities, 160 of which occurred in upland areas, were the result of landslides. Unfortunately however, we have not been able to discriminate between those fatalities caused by floods and those caused by landslides in this event. It is likely that the majority were caused by true river flood events, but it is also likely that tens to hundreds of deaths were caused by landslides. Unfortunately it is likely that we will never be able to resolve this issue. It is also notable that the ongoing dataset on disasters in Nepal, collated independently from our project by the authorities, does not discriminate between floods and landslides even now.

Despite that underestimation of the true impact of landslides in Nepal, we believe that the study reported here yields very interesting information. Notably the database suggests that the occurrence of landslides in Nepal is heavily cyclical, with the cyclicity being dependent upon the variability of the strength of the monsoon. In general it appears that years with strong atmospheric monsoonal conditions are associated with lower numbers of landslide and vice-versa. This seems to concur with an inverse relationship between rainfall patterns in the hill districts of Nepal and the monsoon strength.

The research presented here highlights two issues associated with the triggering of landslides in the Himalayas. First, it is clear that in general the control on the annual occurrence of landslides is the stage of the cycle of monsoon strength. However, on a more local scale, as the 1993 event described above illustrates, many of the landslides themselves are triggered by highly localised extreme precipitation events (cloudbursts). In any given year the number of cloudburst events is probably small, and their impact is spatially limited. Thus, whilst it is possible to state that for a given part of the monsoon cycle a given level of landsliding can be expected, the actual locations of the landslides cannot be determined. Thus, such a study is useful for understanding trends and for forecasting overall impacts, but not for predicting the actual location of events in time and space.

Our data suggest that the occurrence of fatal landslides in Nepal has increased in recent years, and that the level of this increase is greater than would be expected from the natural cyclicity. This increase appears to have occurred primarily in the hill districts of Nepal, but has not led to a change in the number of fatalities per event over and above the normal fluctuation. This suggests that the landscape has become more susceptible to landslides, and we hypothesise that the most likely explanation for this is the rural road-building programme, which coincides with this increase. The effects of deforestation are probably also significant, but the impact is probably lower than might perhaps be expected. There do not appear to be substantial changes in the rainfall pattern occurring at the present time (see for example Nayava 2004), which would preclude climate change effects.

Thus, it would appear that the change in policy in terms of the construction of roads, which is driven at least in part by overseas donor agencies, is leading to increased landslide impacts. This is in agreement with the findings of Sidle et al. (2006), who demonstrated that the density of landslides associated with road construction in mountainous terrains is one and in some cases two orders of magnitude greater than for other land use changes. In Nepal, a remarkably large programme of road construction in (comparatively) high mountain terrain with a climate characterised by seasonal, intense precipitation is underway. In many cases in tectonically active areas, such as the Himalayas, large numbers of slopes are a state of incipient failure (see Petley et al. 2005c for example). In an undisturbed system the trigger for failure would probably be a very large precipitation event (for example a cloudburst) or a seismic shock (see Murphy et al. 2002; Sepulveda et al. 2005; Chen and Petley 2005; Lin et al. 2006 for example). It seems likely that poorly-engineered road construction in effect reduces the size of a potential trigger process, resulting in extensive, large-scale landsliding along the alignment. The resulting impacts are documented in the data presented here.

Whilst the philosophy behind rural access programmes is probably sound, it would appear that better selection of road alignments, enhanced site investigation and increased engineering design would greatly benefit the communities involved. It is an old adage that it is harder to stop a landslide than it is to start one. Thus, it is likely that at least some of the roads constructed under this approach will cause substantial environmental degradation and increased levels of risk for years to come. Future roads should be designed to minimise these impacts.

7 Conclusions

In this study we have examined in detail a large dataset on the occurrence of landslide-induced fatalities in the period 1978–2005. Our data suggest that as Hewitt (1997) proposed, landslides are probably underrepresented as a hazard in mountain environments. They cause a comparatively large numbers of fatalities in Nepal, with most of the landslide deaths in that country being concentrated in the hill districts of the Middle Himalayas. Our data suggest that the impact of landslides is increasing with time, but is strongly controlled by variations in the strength of the monsoon. Interestingly, the relationship shows that when the summer SW Asian monsoon is intense the number of fatalities is low and vice-versa. Whilst this is counter-intuitive, there is now ample evidence that the controlling processes on precipitation in the mountain areas are dominated by the interactions between topography and medium scale airflow patterns (Bookhagen et al. 2005). Thus, the monsoon conditions change the distribution of precipitation on a regional scale such that in years in which the region-wide monsoon is weak, the level of rainfall, and thus the occurrence of landslides is low. Within this pattern, however, there is a strong increasing trend in the number of fatalities occurring in Nepal at any point in the monsoon cycle. Whilst the cause of this increase is not clear, we hypothesise that this may be associated with the ongoing road construction programme in Nepal as well as the effects of deforestation and population changes. If this is indeed shown to be the case then there may be a pressing need to amend the design of rural access development projects in Nepal and many other less developed areas.

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References

Alexander D (1993) Natural disasters. Chapman & Hall, New York, 632 pp

Alexander D (2005) Vulnerability to landslides. In: Glade T, Anderson MG, Crozier MJ (eds) Landslide hazard and risk. Wiley, Chichester, 824 pp

Barling M (2001) Rural-urban migration in Colombia. Geogr Rev 15(1):15–18

Barnard PL, Owen LA, Sharma MC, Finkel RC (2001) Natural and human-induced landsliding in the Garhwal Himalaya of northern India. Geomorphology 40:21–35

Bookhagen B, Thiede RC, Strecker MR (2005) Abnormal monsoon years and their control on erosion and sediment flux in the high, arid northwest Himalaya. Earth Planet Sci Lett 231 (1–2):131–146

Brabb E (1991) The world landslide problem. Episodes 14:52–61

Chalise SR, Shrestha ML, Thapa KB, Shrestha BR, Bajracharya B (1996) Climatic and Hydrological Atlas of Nepal. ICIMOD, Kathmandu, Nepal, 264 pp

Chen H, Petley DN (2005) The impact of landslides and debris flows triggered by Typhoon Mindulle in Taiwan. Q J Eng Geol Hydrogeol 38(3):301–304

Costa JE, Schuster RL (1991) Documented historical landslide dams from around the world. US Geol Surv Open-File Rep 486:91–239

Crozier MJ (2005) Multiple-occurrence regional landslide events in New Zealand: hazard management issues. Landslides 2(4):247–256

Cruden D, Varnes D (1996) Landslide Types and Processes. In: Turner A, Schuster RL (eds) Landslides: investigation and mitigation. Transportation Research Board, National Research Council 247:36–75

Dunning SA, Rosser NJ, Petley DN, Massey CR (2006) in press. Formation and failure of the Tsatichhu landslide dam, Bhutan. Landslides 3(2):107–113, DOI: 10.1007/s10346-005-0032-x

Dussauge C, Grasso JR, Helmstetter A (2003) Statistical analysis of rockfall volume distributions: implications for rockfall dynamics. J Geophys Res 108(B6):2286, DOI: 10.1029/2001JB000650

FAO (2005) Global Forest Resources Assessment (2005). *Forestry Paper* 147, Forestry Department, Food and Agriculture Organization of The United Nations, Rome, Italy, 320 pp

Gerrard AJW, Gardner RAM (2000a) Relationships between rainfall and landsliding in the Middle Hills, Nepal. Nor Geogr Tidsskr 54:74–81

Gerrard J, Gardner RAM (2000b) The nature and management implications of landsliding on irrigated terraces in the Middle Hills of Nepal. Int J Sus Dev World Ecol 7:229–236

Gerrard AJ, Gardner RAM (2002) Relationships between landsliding and land use in the Likhu Khola drainage basin, Middle Hills, Nepal. Mt Res Dev 22(1):48–55

Glade T (2003) Landslide occurrence as a response to land use change: a review of evidence from New Zealand. Catena 51(3–4):297–314

Govil K (2000) Forest resources of Nepal, country report. Forest Resources Assessment Working Paper 016, Forestry department, food and agriculture organization of the United Nations, Rome, Italy, 78 pp

Guzzetti F (2000) Landslide fatalities and the evaluation of landslide risk in Italy. Eng Geol 58:89–107

Hannah DM, Kansakar SR, Gerrard AJ, Rees G (2005) Flow regimes of Himalayan rivers of Nepal: nature and spatial patterns. J Hydrol 308:18–32

Hewitt K (1997) Regions of risk: a geographical introduction to disasters. Addison Wesley Longman, Harlow, UK, 389 pp

Hittelman AM, Lockridge PA, Whiteside LS, Lander JF (2001) Interpretive pitfalls in historical hazards data. Nat Hazards 23(2–3):315–338

Horii T, Hanawa K (2004) A relationship between timing of El Niño onset and subsequent evolution. Geophys Res Lett 31:L063041–L063044

Hovius N, Stark CP, Allen PA (1997) Sediment flux from a mountain belt derived by landslide mapping. Geology 25:231–234

Hovius N, Stark CP, Hao-Tsu C, Lin JC (2000) Supply and removal of sediment in a landslide-dominated mountain belt: Central Range, Taiwan. J Geol 108:73–89

Joshi AL (1998) Underlying Causes of Deforestation and Participatory Forest Management Policy in Nepal. Proceedings of the IGES International Workshop on Forest Conservation Strategies for the Asia and Pacific Region. Available online: http://www.iges.or.jp/en/fc/phase1/1ws-contents.htm

Li J, Zeng Q (2003) A new monsoon index and the geographical distribution of the global monsoons. Adv Atmos Sci 20:299–302

Lin JC, Petley DN, Jen CH, Hsu ML (2006) Slope movements in a dynamic environment—A case study of Tachia river, Central Taiwan. Q Int 147(1):103–112

Malamud BD, Turcotte DL, Guzzetti F, Reichenbach P (2004) Landslide inventories and their statistical properties. Earth Sur Processes Landforms 29:687–711

Murphy W, Petley DN, Bommer J, Mankelow JW, (2002) Geotechnical and seismological uncertainty in the assessment of slope stability during earthquakes. Q J Eng Geol Hydrogeol 35:71–78

Nayava JL (2004) The temporal variations in rainfall in Nepal since 1971 to 2000. J Hydrol Meteorol 1(1):24–33

Owen LA, Sharma M, Bigwood R (1995) Mass movement hazard in the Garhwal Himalaya: the effects of the 20th October 1991 Garhwal earthquake and the July-August monsoon season. In: McGregor DFM, Thompson DA (eds) Geomorphology and land management in a changing environment. London, Wiley, 69–88

Parthasarathy B, Munot AA, Kothawale DR (1995) Monthly and seasonal rainfall series for All-India homogeneous regions and meteorological subdivisions: 1871–1994. Indian Institute of Tropical Meteorolgy Research Report RR–065, Pune 411 008, India

Petley DN, Dunning SA, Rosser NJ (2005a) The analysis of global landslide risk through the creation of a database of worldwide landslide fatalities. In: Hungr O, Fell R, Couture R, Eberhardt E (eds) Landslide risk management, AT Balkema, Amsterdam, 367–374

Petley DN, Hearn GJ, Hart A (2005b) Towards the development of a landslide risk assessment for rural roads in Nepal. In: Glade T, Anderson M, Crozier MJ (eds) Landslide hazard and risk, Wiley, Chichester, 597–620

Petley DN, Higuchi T, Petley DJ, Bulmer MH, Carey J (2005c) The development of progressive landslide failure in cohesive materials. Geology 33(3):201–204

Petley DN, Oven K, Mitchell WA, Rosser NJ, Dunning SA, Allison RJ (2006) The role of global and regional precipitation patterns in landslide generation. In: Ashaari M (ed) Proceedings of the International conference on slopes Malaysia 2006. Public Works Department, Kuala Lumpur, pp 249–268

Sah MP, Mazari RK (1998) Anthropogenically accelerated mass movement, Kulu Valley, Himachal Pradesh, India. Geomorphology 26(1–3):123–138

Sarkar S, Kanungo DP, Mehrotra GS (1995) Landslide hazard zonation: a case study in Garhwal Himalaya, India. Mt Res Dev 15(4):301–309

Schuster RL, Highland LM (2001) Socioeconomic and environmental impacts of landslides in the western hemisphere, USGS Open-File Report, 01–276

Sepúlveda S, Murphy W, Jibson RW, Petley DN (2005) Seismically-induced rock slope failures resulting from topographic amplification of strong ground motions: the case of pacoima canyon, California. Eng Geol 80(3–4):336–348

Shrestha AB, Wake CP, Dibb JE, Mayewski PA (2000) Precipitation fluctuations in the Nepal Himalaya and its vicinity and relationship with some large scale climatological parameters. Int J Climatol 20(3):317–327

Sidle RC, Ziegler AD, Negishi JN Nik AR, Siew R, Turkelboom F (2006) Erosion processes in steep terrain—Truths, myths, and uncertainties related to forest management in Southeast Asia. Forest Ecology and Management 224(1–2):199–225

Stark CP, Hovius N (2001) The characterization of landslide size distributions. Geophys Res Lett 28:1091–1094

Turcotte DL (1999) Self-organized criticality. Reports on Progress in Physics 62:1377–1429

Information and Consent Form
Date:

Title of study:	Landscape, livelihoods and risk: a study of community vulnerability to landslides in Central Nepal.
Co-ordinated by:	Katie Oven Department of Geography Durham University UK k.j.oven@dur.ac.uk
Academic supervisors:	Professor David Petley Professor Jonathan Rigg Dr Christine Dunn
Institutional funders:	This study has been funded by the Durham University Doctoral Fellowship Scheme, the International Landslide Centre and the Royal Society Dudley Stamp Memorial Fund.
Approval:	This research has been approved by the Geography Department Ethics Committee, Durham University, UK.

Purpose:
We have been undertaking a three year study into landslide risk and vulnerability in the Nepal Himalaya. Specifically, the research has examined the following questions:

1. Who is vulnerable to landslides hazards?
2. Why do people occupy landslide prone areas?
3. How are physical risks perceived and understood?
4. How do people respond to landslide hazard both immediately and in the long term?

The study has focused on the Upper Bhote Koshi Valley in Sindhupalchok District and has included a detailed study of the settlements of Chaku, Larcha, Kodari, Marmin, Duguna and Listi.

The second phase of the research explores how outside 'specialists' (geologists, engineers, livelihoods advisors, NGOs etc.) view landslide hazard and risk in Nepal and how policy is subsequently informed and shaped. In doing do, the research investigates how we can progress and combine local understanding with outside 'specialist' knowledge to increase household and community resilience to landslides.

Interview:
[Name and affiliation of interviewee]

The aims of the interview are:

1. To present the findings from a three year study into landslide vulnerability in Nepal;

2. to discuss the relevance of the findings to DFID who are funding a number of road construction projects in the rural sector;
3. to discuss the issues surrounding current policy and practice;
4. to share the findings from a recent workshop on vulnerability reduction and resilience building along road corridors.

Potential benefits

This research will help to develop our understanding of the underlying causes of vulnerability with a view to increasing the resilience of 'at risk' populations. We will be sharing our findings with a range of stakeholder groups involved in road construction, landslide mitigation and management and disaster risk reduction activities.

Confidentiality

We would like to record this interview. This will be used for reference only by the research team and will be destroyed after use. Notes will also be taken throughout. The information provided during the interview will be used in my Ph.D. thesis and subsequent publications. Please inform me if you wish to remain anonymous.

Thank you for your continued interest in the research.

Kind regards

Katie Oven

Doctoral Researcher
Department of Geography
Durham University
UK

Kathmandu Guesthouse
Thamel
Tel: 4700 800 / 4700 632

Consent form

Name:

Affiliation:

Date:

This interview will be recorded and used for reference by the research team only. The recording will be destroyed after use. Notes will also be taken throughout. The information provided during the interview will be used by the researcher (Katie Oven) in her Ph.D. thesis and in subsequent publications. If you wish to remain anonymous, please inform the project co-ordinator, Katie Oven after the interview. Should you have any questions about the research, please contact Katie directly.

Thank you

Signature	Signature
Katie Oven	*[Insert name of interviewee]*

Doctoral Researcher
Durham University, UK.

Interviewer: Date:

Settlement and VDC:

Name of informant:

1. Settlement Form

(Aim: to develop an understanding of traditional settlement form and how people respond to the physical environment. Do the villagers recognise environmental hazards e.g. landslides and do they make provision for them in terms of settlement layout?).

1.1 Begin by describing the village settlement. What are the main geomorphological (physical) features? Describe the layout of the settlement in relation to these features.

1.2 Produce a land use map and undertake a photographic survey of the settlement. The map should identify the following:

streams/rivers	houses
steep slopes	shops
agricultural land	places of worship (temples/shrines etc.)
grazing land	school
woodland	health centre
roads/tracks/footpaths	official buildings
other places of interest.	

You should begin to identify the areas at risk from environmental hazards e.g. landslide events.

1.3 Undertake a walkover survey with the village elder. This will involve walking from one end of the village to the other. Talk to the village elder about the landscape and the layout of the settlement. Key questions:

Who lives where?
What is the land used for and why? You should distinguish between agricultural land and settled land.
What is the oldest part of the settlement?
How has the settlement changed/expanded over time?
Is the village susceptible to landslides and/or debris flow events?
If yes, identify the main areas at risk from landslide related hazards.
Has any land been abandoned? If yes, why?

The information collected will be used to create a social map of the village. GPS readings will be taken to locate areas of interest for example, houses that have been affected by landslide events.

2. Village Profile
(Aim: to determine who lives in the hill villages)

2.1 How many people live in the village?

2.2 How many households are there in the village?

2.3 Are any of the households headed by women? If yes, please identify the households *permanently* headed by women and the households *effectively* headed by women (i.e. households where the male has been away for one year or more).

2.4 To which caste/ethnic groups do the villagers belong?

Caste group	**Families/households** *(please specify)*
Upper/high caste groups *(Brahmin, Chhetri, Newari, Thakuri)*	
Low/occupational caste groups *(Sunar, Lohar, Chadra, Okheda, Sarki, Damai, Sanai, Badi, Hudke)*	
Hill tribes *(Gurung, Magar, Limbu, Rai, Tamang, Sherpa, Bhote)*	

2.5 What are the main economic activities?

Economic activity	**Families/households** *(please specify)*
Farm work on own land	
Agricultural labour	
Day/wage labour *(e.g. road maintenance)*	
Formal employment *(e.g. teaching, health services, VDC/DDC officials)*	
Seasonal migration *(e.g. to the Terai, India, Middle East or the Gurkha Army)*	
Business *(e.g. providing transport services, importing goods)*	
Other, please specify	

3. Settlement Patterns
(Aim: to investigate changes in the settlement pattern over time)

3.1 How old is the village settlement?

3.2 Why did people choose to settle here?

3.3 How has the settlement pattern changed over time?
(Ideas: migration into and out of the village /the impact of road construction).

3.3.1 How many households have left the village in the last five years?

3.3.2 What were the reasons for their migration?

3.3.3 How many households have members living away from the village?

3.3.4 Has the village experienced any inward migration? If yes, please give details.

4. Building Materials and Access to Services
(Aim: to assess village poverty levels)

4.1 Which building materials are used to construct the houses? *(Tally the number of houses constructed using each material).*

Stone	Brick	Bamboo	Clay	Wood	Other

4.2 Which roofing materials are used? *(Tally the number of houses).*

Thatch	Corrugated sheet	Tiles	Slates	Concrete	Other

4.3 From where does the village source its water?

4.4 Does the village have toilet facilities?

4.5 Does the village have electricity? If yes, for how long has the village had electricity?

4.6 Which health care services are available and where are they located?

Health care service	**Location**
Traditional healer	
Ayurevedic centre	
Sub-health post	
Health post	
Mobile clinic	

4.7 Where do the children go to school?

4.8 Do villagers have access to a bank?

Yes No

4.9 Do villagers have access to a post office?

Yes No

4.10 Do villagers have access to telephone services?

Yes No

4.11 How far away is the district centre?

4.12 How do villagers travel to the district centre?

Walk Bus Lorry Bicycle Tractor

Other, please specify

4.13 Do households have radios/televisions? If yes, please identify these households.

4.14 Are there any community groups active within the village? *(E.g. mothers' group/ womens' group/forestry groups etc.*

5. Landslide Hazards
(Aim: to determine how the village has been affected by landslide activity in the past)

5.1 Has the community been directly affected by landslides?

By landslides we are referring to:
rock/debris/soil slides
rock falls
debris/mud flows (these are often associated with flooding).

5.2 How frequently (often) do landslides occur in the village?

5.3 During which months of the year do landslides mainly occur? *(Please circle)*

Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec

5.4 Ask the village elders to describe the landslide events they have experienced and complete the following case study sheets.

Case study 1

Date and time of occurrence:

Landslide type (please tick):

falling rocks
rivers of mud/debris
sliding soil

Number of people killed:

Number of people injured:

Landslide impacts *(e.g. houses destroyed/road blocked)*:

Households affected by the event:

Case study 2

Date and time of occurrence:

Landslide type (please tick):

falling rocks
rivers of mud/debris
sliding soil

Number of people killed:

Number of people injured:

Landslide impacts *(e.g. houses destroyed/road blocked)*:

Households affected by the event:

Case study 3

Date and time of occurrence:

Landslide type (please tick):

falling rocks
rivers of mud/debris
sliding soil

Number of people killed:

Number of people injured:

Landslide impacts *(e.g. houses destroyed/road blocked)*:

Households affected by the event:

Appendix 3 – Vulnerability and Capacity Analysis Framework (adapted from Anderson and Woodrow, 1989)

	Capacities (strengths)	**Vulnerabilities (weaknesses)**
Physical/material Hazards, resources, skills		
Social/organisational Relations and organisations among people		
Motivational/attitudinal The ability to create change		

Interviewer: Date:

Settlement and VDC:

Name of Informant:

Following the completion of the community profile, the following table will be completed with the help of the village elder. Households will then be selected and interviews conducted.

The snowball sampling strategy will be adopted with the aim of selecting "information-rich cases".

Category	**Households**
High-caste households	
Low-caste households	
Hill-tribes	
Relatively rich households	
Middle income households	
Relatively poor households	

Households classified as destitute	
The eldest residents of the village	
Households with a female head	*Permanently headed by women* *Effectively headed by women*
Households that have been directly affected by a landslide	
Split households (i.e. where some family members live away from the village)	
Villagers who are active members of community groups/projects e.g. community forest projects, pollution management, mothers' groups etc.	
Other, please specify	

Interviewer: Date:

Settlement and VDC:

Household: GPS:

Name of informant *(this will normally be the head of the household)*:

Aim: to gather baseline data/information concerning the socio-economic conditions of households within the research area.

1. Trace Indicators

Begin by describing the household living conditions and their fixed assets. You should include and comment upon the following:

- The location of the family house, buildings and farmland in relation to the physical environment
- The building materials used and the quality of construction:
  Pakka (cement, bricks, tiles etc.)
  Katchi (mud, thatch, wood etc.)
- The number of buildings
- The number of storeys, rooms and the layout of the main house
- The interior of the house
- Consumer goods e.g. radios and televisions

2. Household Profile

2.1 Caste/ethnic group and religion:

Upper/high caste groups	*Brahmin, Chhetri, Newari, Thakuri*
Low/occupational caste groups	*Sunar, Lohar, Chadra, Okheda, Sarki, Damai, Sanai, Badi, Hudke*
Hill tribes	*Gurung, Magar, Limbu, Rai, Tamang, Sherpa, Bhote.*

2.2 How many people are there in the household?

Name	Sex	Age	Education	Economic Activity	Do they reside in the village?

Coding System

Education:

1 Non-literate
2 Education to primary level
3 Education to secondary level
4 School leaving certificate
5 Collage certificate level (achieved after a 2 year college course)
6 Other, please specify

Economic activity:

1 Farm work on own land
2 Farm work on own land and sharecropping
3 Sharecropping *"adhiya" (halves)*
4 Agricultural labouring
5 Off farm employment *(e.g. construction worker, road maintenance)*
6 Formal employment *(e.g. teaching, health services, VDC/DDC officials)*
7 Seasonal migration *(e.g. to the Terrai, India, Middle East or the Gurkha Army)*
8 Business *(e.g. providing transport services; importing goods)*
9 Student
10 Other, please specify
11 None

2.3 For those who reside outside the village, please complete the following:

Name	Where are they living?	When do they return to the village?	How long do they spend in the village per month or per year?	Do they remit funds?

2.4 Does the household have any extended family living outside the village?

Yes No

Please give details

2.5 Was the head of the household born in the village?

2.6 How many generations of the family have lived in the village?

2.7 If they are the first generation, how many years ago did the head of the household move to the village?

2.8 Where did they move from?

2.9 What was the reason for the migration?

Land purchase
Acquired land by gift
Male married in
Other, please specify
Better opportunities
Came as a child
Wage labour

3. Assets

3.1 Is the house owned or rented?

Owned Rented

3.2 Is the house plot owned, rented or illegally occupied?

Owned Rented Government land (illegal occupation)

3.3 If the house is owned, did they build or inherit the house?

Built Inherited

3.4 If the former, why did they choose this particular location to construct their house?

3.5 Land-holdings - how much land is owned and cropped?

Tenure	<10 ropanis	10-20 ropanis	20-30 ropanis	>30 ropanis *(please specify)*
Owned				
Share-cropped				
Tenant				
Other				

Please indicate whether the farmland is irrigated (IRR) or rain-fed (RF).

3.6 Does the household rent any of their land to others?

Yes No

3.7 If yes, how much land is rented?

_________ ropanis

3.8 Does the household own livestock?

	Number		Number
Cattle		Pigs	
Buffaloes		Chickens	
Goats		Other, please specify	

3.9 Food sufficiency/security - for how many months of the year can the household produce their own food?

<3 months	3<6 months	6<9 months	9≤12 months	Surplus

3.10 How do they provide food during the months when the household is unable to produce its own food?

Loan	Buy grain	Day wage labour	Eat wild foodstuffs	Other, please state

4. Income

4.1 What is the household's main source of cash income? How much does the household earn from this activity? *(Please complete the table below).*

4.2 What is the household's second source of cash income? How much does the household earn from this activity? *(Please complete the table below).*

4.3 What is the household's third source of cash income? How much does the household earn from this activity? *(Please complete the table below).*

Income source	Household earnings (Rs)
Agriculture	
Crops	
Livestock	
Livestock products	
Vegetables and fruit	
Horticulture	
Wage labour	
Formal employment	
Business	
Pension/remittance/interest/rent	

4.4 How reliable are these sources of cash income?

Please use the following as a guide:
How many sources of cash income does the household have?

Formal employment	*For how many years have they been employed?*
Day-wage labour	*How many days in a month do they work and for how many months of the year are they employed?*
Business owners	*For how long have they been running their business?*
For all	*How much money do they earn on a daily, weekly or monthly basis?*

4.5 Has the household ever taken out a loan?

Yes No

4.6 If yes, what was the loan used for?

To build the family house	Trade
To acquire land	Medical expenses
To buy animals	General expenses
Agricultural inputs e.g. seeds/fertilizer	Other, please specify.

4.7 Where did the household source the loan?

Family	Bank
Other villagers	Other, please specify.

4.8 Has the household paid back the loan?

Yes No

4.9 Has the household ever loaned money?

Yes No

5. Household Needs

What are the main and urgent needs of the household?

1.

2.

3.

6. Additional Information

Record here any additional information which may be of interest.

Interviewer: Date:

Settlement and VDC: Household:

Name of interviewee:

1. Risk Perceptions
(Aim: to investigate how physical risks are perceived and understood).

1.1 The monsoon rains are about to begin. What causes these annual rains to occur? *(Ideas: nature/God).*

1.2 What are the impacts of the monsoon rains on the village community? *(Ideas: the monsoon rains may be viewed* ***positively*** *– the rains maintain the fertility of the farmland or* ***negatively*** *– they cause floods/landslides etc.).*

1.3 Are the monsoon rains welcomed by the villagers?

Yes No

Please give details.

1.4 Were the monsoon rains heavy last year?

Yes No

Please give details.

1.5 Many hill villages in Nepal experience landslide activity. What causes/triggers these landslide events?
(Ideas: product of nature/ God/ the movement of giant snakes below the ground (Hindu mythology)/ environmental change (e.g. deforestation)/ failure of government departments to stabilise the slopes).

2. Response

(Aim: to investigate how people respond to landslide hazard and risk).

2.1 How is the household preparing for the annual monsoon rains?
(Ideas: Do people adapt their lifestyle/daily routine or attempt to mitigate against the impact of the monsoon rains? Perhaps they do nothing and simply accept their fate?).

2.2 Are they concerned about the threat of landslide activity?

Yes No

Please give details.

If yes, please continue.

2.3 Do they believe that the dangers faced can be actively reduced?
(Ideas: no – hazards are uncontrollable/unpredictable or yes – through engineering/housing relocation etc.).

Yes No

2.4 What actions are being taken at the individual, household, community and government/NGO level?
(Ideas: small scale structural/engineering measures, agricultural adjustments, action by government departments etc.)

Individual level

Household level

Community level

Government level

Other agencies (NGOs etc.).

2.5 Are early warnings about landslides or floods issued to the community?

Yes No

2.6 If yes, how?
(Ideas: press, radio, television, local organisations etc.)

2.6.1 If an early warning was issued to the household/community what would their response be?
(I.e. would the household evacuate? If so, where would they go?).

Interviewer: Date:

Settlement and VDC: Household:

Name of interviewee

Aim: to gain an insight into peoples' experiences of landslide activity.

The following questions should act as a guide. You should encourage the interviewee to talk openly about their experiences of landslide activity.

Begin by asking the villager about their daily life, their routines, their roles within the household and their day to day decision making.

Key questions:

1. Where and when did the landslide event occur?
   (Date and time)

2. What type of landslide event was triggered?
   (Falling rocks/rivers of mud/debris /sliding soil)

3. What was the trigger/cause of the landslide event?

4 What were you doing when the landslide/debris flow occurred?

5. What was your immediate response? What did you do?

6. What was the impact of the event? Was anyone killed or injured? How many houses were destroyed?

7. Did you receive any emergency assistance? If yes, who offered/provided this assistance?
   (Ideas: family/ friends/community groups/ police/ army/ fire and rescue).

8. How did you respond both immediately and in the long-term?
   (Ideas: relocate/religious response)

9. Did you receive any compensation?

10. Do you worry about the reoccurrence of landslide events in the future?

11. Do you believe that the household and community as a whole can actively reduce the dangers faced?
    (Ideas: Yes – through engineering etc. or No – landslides are uncontrollable/ unpredictable).

12. Have any adjustments been made at the household and/or community level to prevent landslide disasters in the future?

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2 June 2008

Dear All

Thank you for your interest in the forthcoming workshop on landslide vulnerability in Nepal. The event will be held on Monday 9th June at ICIMOD. The workshop will be coordinated by myself, Katie Oven, and Professor David Petley from the International Landslide Centre and the Institute of Hazard and Risk Research in the Department of Geography, Durham University, UK. Registration for the workshop will take place at 9:00 with the introductory session beginning at 9:30. We will conclude the workshop with lunch, scheduled for 13:00. A detailed agenda will be available on arrival.

Aims and objectives of the workshop

The principle aim of the workshop is to disseminate the findings from a three year study into landslide vulnerability in Central Nepal. Following the presentation there will be an opportunity for questions. This session will then feed into a discussion to identify ways forward, i.e. how can we combine local understanding with outside 'specialist' knowledge in order to increase the resilience of communities to landslides in the Nepal Himalaya. We are keen to have a tangible outcome from the workshop and propose the initial formulation of a project which can be taken forward.

The workshop will bring together five stakeholder groups working within the field of road construction; landslide mitigation and management; and disaster risk reduction. These include:

- Government ministries and departments
- Technical specialists (geologists/engineers)
- Livelihood and development specialists
- Bilateral agencies
- NGOs

The meeting/group interview will be facilitated by myself, Katie Oven with notes taken throughout by my Nepali co-researcher, Kiran Kharel. The information gathered during the discussion will be circulated to participants in the form of a preliminary meeting report and will be included in Katie's final
Ph.D. thesis and subsequent journal publications.

Logistical arrangements
Transport has been arranged for participants from Kathmandu. The ICIMOD vehicle will depart from New Road Gate, near the Nepal Airlines Corporation at 8:30 am. Tea/coffee and lunch will be provided at ICIMOD. Please let me know if you will be requiring transport and if you are a vegetarian or have any special dietary requirements by Thursday 5 June.

There will be no financial cost to participants other than your time. If you have not already done so, please confirm your attendance at the workshop by email to k.j.oven@durham.ac.uk. Should you wish to contact me directly, I am staying at the Kathmandu Guest House (tel: 4700800). Please ask for room 218.

Once again, thank you for your continued interest and support for my Ph.D. research. I look forward to meeting you on Monday.

Kind regards

Katie Oven

Research postgraduate

Institute of Hazard and Risk Research

Durham University

International Landslide Centre

Workshop Report

Landslides, risk and decision-making in Central Nepal: a multi-stakeholder approach

Monday 9th June 2008

Venue: ICIMOD, Khumaltar, Lalitpur, Nepal

In association with
the International Landslide Centre and the Institute of Hazard and Risk Research
Department of Geography, Durham University, UK

Introduction

The occurrence of fatal landslides in Nepal is increasing with time, faster than the effects of monsoonal variations. Possible explanations for the trends observed include land-use change, population growth, and civil war - each of which impacts on household and community vulnerability. In addition, the impact of climate change on monsoon intensity (which strongly controls landsliding) is poorly understood, raising questions regarding future vulnerability in Nepal. To address these issues, the research presented takes an inter-disciplinary, bottom-up approach to answer four questions: who is vulnerable to landslides; why do people occupy landslide prone areas; how is landslide risk perceived and understood in these locations; and, finally, how do people respond immediately and in the long-term to landslide hazard and risk?

The findings to date highlight the impact of infrastructure projects in rural Nepal. Within the Upper Bhote Koshi Valley, Sindhupalchok District clear transitions in settlement patterns and rural livelihoods (and thus the occupation of landslide prone areas), have been seen over time. Households occupy hazard prone areas through lack of choice, as fixed assets bind them to a particular location; through choices to take advantage of a roadside location; or through a lack of awareness of the risk associated with potential slope failures. There was both natural and supra-natural reasoning attributed as causes of landslide activity; with responses including risk denial/rejection, passive acceptance of risk, or taking action to reduce further losses.

Based on these findings, the second phase of the research explores how scientists and policy experts view landslide hazard and risk and how policy is subsequently informed and shaped. In doing so, this research challenges the traditional top-down, technocratic approach to disaster management and seeks to explore the ways in which local understanding can be developed and combined with outside specialist knowledge to increase household and community resilience.

Workshop aims and objectives

1. To disseminate the findings from a 3 year study on landslide vulnerability in Central Nepal;
2. to determine if the observations from the study apply elsewhere in Nepal;
3. to identify ways forward - how can we combine local understanding with outside ‘specialist’ knowledge in order to increase the resilience of communities to landslides in the Nepal Himalaya?

Institute of Hazard and Risk Research | Durham University | International Landslide Centre

The workshop involved five stakeholder groups working within the fields of road construction; landslide mitigation and management; and disaster risk reduction (DRR). These included government ministries and departments, technical specialists (geologists/engineers), livelihood and development specialists, multilateral agencies and NGOs.

Session 1: Presentation feedback

The workshop began with a presentation of the research findings and a discussion session. The following is a summary of the points discussed:

Landslide risk and vulnerability in Nepal

- Landslides represent a significant problem in the mountain areas of Nepal. This largely reflects the physiographical characteristics of the country. However, the presence and activities of people have increased the occurrence of landslides and the vulnerability of the population.
- The construction of roads, particularly unplanned local roads, has been linked to the increasing occurrence of landslides in the Himalaya. However, at present, the impact of road construction on landslide generation is poorly quantified.
- The relocation of people to roadside sites, which are often more susceptible to landslides than the location of their original houses, is of particular concern. Such patterns of roadside migration have been observed elsewhere in Nepal suggesting this pattern is representative of the wider situation.

Risk perception and response

- While the landslide prone sites at the roadside are occupied by both relatively rich and relatively poor households, the poorest/most destitute households are the most vulnerable to landslide hazard. This reflects their reduced adaptive and coping capacity.
- Two overarching themes have emerged with regard to indigenous people's perceptions of landslide risk: a natural/scientific and a supra-natural understanding.
    - Local people were often aware that they live in a landslide prone environment and make clear links between steep slopes, heavy and prolonged monsoon rainfall and resulting landslide activity. Links were also made between deforestation; the quarrying of slate; river undercutting and incision; and in some cases road construction and mass movement. These findings are likely to reflect the strong social-environmental interaction inherent in mountain communities.
    - Supra-natural explanations were also given whereby landslides were viewed as the work of the deities or gods. Such explanations emerged when there was no obvious physical trigger for a landslide or when the event was considered beyond the control of the community.
- The migration associated with road construction is exposing people to new hazards e.g. debris flows. In some cases households were found to be unaware of the threat associated with landslide/debris flow activity in their new location (reflecting the absence of inter-generational knowledge) and did not recognise the warning signs associated with an unfamiliar hazard.

- Others were found to be aware of the risk associated with a particular hazard but they rejected the risk as the occurrence of the hazard was deemed beyond their control. This is often referred to as fatalism or denial.
- Households were found to attach minimal importance to landslide risk. Instead they were found to have more pressing everyday livelihood concerns. What at first appeared to be 'risky actions', such as, constructing a house on government land at the bottom of a steep, unstable slope prone to failure, were in fact 'risk-averse' strategies undertaken in the context of the everyday risks faced they face. These risks were largely concerned with access to water, healthcare, income, education etc.

Land-use policy and practice

- Inappropriate land-use practices are of particular concern. The Ministry of Forests and Soil Conservation is currently revising Nepal's land-use policy to enable more effective mitigation and management of landslide hazard. However, such policy is difficult to enforce when land is privately owned.

To do

- The findings from the study should be quantified e.g. the percentage of households sampled in each case study village.
- The baseline vulnerability data should be included in the analysis.
- Compare the level of risk associated with landslide hazard along the road corridor.

Areas for further inquiry

- Quantitatively demonstrate the processes described e.g. migration associated with road construction.
- Widen the scope of the research in terms of its geographical area e.g. investigate the impact of a range of roads including strategic, feeder and locally constructed unplanned roads on the landscape and the vulnerability of people through time.

Session 2: Vulnerability reduction and resilience building

For this session the group was initially divided into mixed stakeholder groups to brainstorm the question: 'what can be done to reduce landslide vulnerability along road corridors?' Groups were encouraged to share their ideas in a feedback session which fed into a plenary discussion on vulnerability reduction and resilience building in Nepal. A summary of the points discussed and questions raised are set out below.

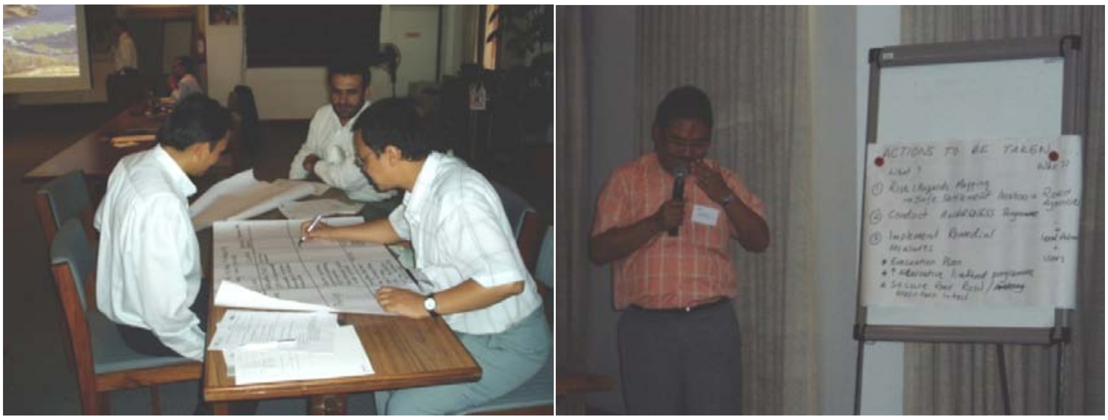
Does the frequency of catastrophic events justify the resources that would be required to reduce people's vulnerability?

[Should landslides be one of the key issues we are trying to address or are landslides secondary to the other threats people face? Can we disentangle the two?]

The general consensus was yes - the resource expenditure is justified.

- Landslides are one of many hazards affecting Nepal. Landslides can be catastrophic but it is the cumulative nature of the hazard which is also a cause for concern. High frequency but low magnitude events destroy property and farmland and undermine livelihoods.

- In a recent study undertaken for the Willis Research Network (reference to follow), the cost of landslides was found to be greater than other hazards. Examples include New Zealand, Japan (even allowing for the cost of the Kobe earthquake) and the USA. DNP suspects we would find the same pattern in Nepal over the last 30 years in terms of GDP.
- Landslides can, and do, undermine development.
- We should not underestimate the potential for a high magnitude, low frequency event in the future.



Small group discussion and feedback session

2. Is it possible to increase landslide resilience and enhance livelihoods in Nepal?

As before, the general consensus was yes – it is possible to increase landslide resilience and enhance livelihoods along road corridors. The question is how to do this effectively?

The suggested structures, policies and programs are summarised below:

1. Avoid the hazard

A detailed geomorphological assessment (this should feature in the formal Environmental Impact Assessment (EIA) policy guidelines) should be undertaken when choosing the initial road alignment to avoid existing landslides and to minimise future hazard. Following the construction of the road, hazard and risk maps should be prepared. Again, this should be part of the compulsory EIA.

2. Discourage roadside migration

Infrastructure and services including water, healthcare facilities, schools etc. should be provided in the hill villages to discourage roadside migration. Feeder roads could also be constructed to provide access to the road whilst reducing the need to live directly by it. But, who should take responsibility for this and fund the construction of additional feeder roads?

3. Planning for roadside settlements
When designing roads government and donor agencies should plan for the establishment of roadside settlements. The road corridor should be zoned to identify the high risk areas to be avoided and the low risk areas suitable for human occupancy. It is recognised that it is difficult, if not impossible, to stop encroachment even into high risk areas. With this in mind, communities should be given alternative livelihoods opportunities in safer areas to encourage them to live away from the high risk zones. However, this raises a series of questions around the issue of funding and implementation.

4. Land-use policy
Effective land-use policy should be established which addresses landslide hazard and enhances livelihoods e.g. encouraging communities to convert to ginger or cardamom production or to establish tea plantations which do not require the same amount of irrigation as paddy fields. However, it is important to consider if there is a market for these non-rice commodities. For communities heavily reliant on subsistence agriculture, how will they feed themselves?

5. Public awareness/education
Public awareness/education programmes are considered essential to ensure people are aware of landslide and debris flow hazards. If people migrate to a new location it is important they are aware of the new hazards they are exposed to and the risks they face. It is necessary to ensure households and communities are aware of the warning signs indicative of landslide and debris flow hazards.

6. Early warning systems
Early warning systems should be established which build on local knowledge.

7. Preparedness, planning and capacity building
Local institutions e.g. Women's Groups should be strengthened. Such groups will enhance the capacity of the community to respond to a hazard. Evacuations plans should be developed at the local level. Insurance funds should be established within the local community to help share the loss/burden associated with disasters. The role of local institutions is essential to ensure there is local ownership of DRR projects.

Examples of successful landslide management practices elsewhere were discussed. Hong Kong successfully manages landslide hazard through hazard assessment and zonation, effective land-use policy, geotechnical engineering and awareness raising campaigns. However, Hong Kong is a city state. Would such policies work in Nepal? This raises a series of questions regarding feasibility, the targeting of already scarce resources and the governance of DRR.

3. Who should be responsible for implementation?
While there was much common ground between participants regarding the structures, polices and programs needed to increase community resilience to landslides, suggested methods for implementation varied between groups and were both top-down and bottom-up. These ideas are summarised below:

- Local **and** outside scientific knowledge is recognised as being important.

- There is a lack of coordination between the stakeholder groups involved in landslide mitigation and management and DRR activities. A central coordinating body is therefore needed to advise the government on policy and practice.
- DRR is everyone's responsibility but the central government is ultimately responsible. The government should facilitate DRR at all levels – centrally, regionally and locally.
- The government is responsible for mainstreaming DRR policy into the relevant ministries, departments and the associated donor agencies e.g. DFID. DRR policy must include policies on landslide mitigation and management and vulnerability reduction.
- The government is responsible for overseeing the decentralisation of DRR. Decentralisation will only be effective if people are given the skills, knowledge and financial support to undertake DRR activities at the regional, district and local level.
- The agencies undertaking development projects e.g. infrastructure development must take responsibility for landslide hazard management and DRR. Projects should be audited to ensure they meet with the guidelines and policy set out by the government.
- It is important that local people take ownership of DRR projects. To achieve this, a bottom-up, participatory approach which builds on existing local knowledge is necessary.

The following **barriers** to successful implementation were identified:

- a lack of political commitment and the absence of policy concerning DRR;
- limited financial resources;
- the attitudes and beliefs of 'at risk' communities.

Ways forward – project suggestions

The following suggestions were proposed by Katie Oven.

Stage 1: Formation of a national landslide advisory body

Nepal's national landslide advisory body would involve the relevant stakeholder groups including the government ministries and departments, technical specialists (geologists/engineers), livelihood and development specialists, multi- and bilateral agencies and NGOs. The advisory body would build upon the already established Nepal Landslide Society and the newly proposed Himalayan Society for Landslides and the Environment and would inform and shape policy regarding landslide management and vulnerability reduction centrally.

Stage 2: Mainstreaming landslide management and vulnerability reduction

This could be undertaken with guidance from the national landslide advisory body; the UNDP (who are overseeing Nepal's Disaster Risk Management Strategy); and the National Disaster Management Centre who are advising the government on DRR policy. The UNDP are already piloting a decentralisation programme within the government ministries and this may be a way of mainstreaming landslide management and vulnerability reduction into the relevant departments e.g. the Department of Local Infrastructure Development and Agricultural Roads. It is also essential to mainstream within the multi- and bilateral agencies who are funding road construction projects e.g. the ADB and DFID.

Stage 3: Decentralising DRR
It is essential to enhance the capacity of communities to manage landslide risk at the local level. Currently households see landslides as a hazard beyond their control. Education and awareness raising programmes are therefore critically important. Decentralisation will only be effective if the necessary training and budget is made available at the district and local level.

It is recognised that these are ideas only and any successful intervention must come from the concerned stakeholders in Nepal.

Summary/conclusion
Landslides represent a significant problem in the mountain areas of Nepal. This largely reflects the physiographical characteristics of the country but the presence and activities of people have increased the occurrence of landslides and the vulnerability of the population.

Undoubtedly, roads influence livelihood trajectories and bring about social change. When roads are constructed and access is provided, the process of **outmigration and resettlement is inevitable**. While road construction may enhance certain livelihood elements, leaving people vulnerable to landslide hazards undermines development objectives. Despite this, with many communities still isolated, the main objective of the government's Interim Plan (National Planning Commission 2007) is to further expand the road network through the construction of national and regional highways and major roads at local level. **It is therefore a logical step for future road design to take into account migration and roadside settlements.**

Understanding what makes people vulnerable to landslides and how exposed households and communities perceive the risks they face are first steps towards effective DRR. To achieve this we must consider the role of human agency and recognise alternative framings of risk. For the exposed communities themselves, these risks are largely concerned with human security, everyday needs and wellbeing. From the context of an 'outside researcher' what may appear to be 'risky actions' are often, in fact, 'risk-averse' strategies. **This does not mean that we should negate the management of landslides but rather that we should look towards devising interventions which reduce landslide risk whilst meeting the basic needs of the exposed populations**. While it is important that interventions do not undermine development, it is sometimes possible to address the threats associated with a particular hazard without addressing broader development issues. Partitioning the problem and being realistic about what can be achieved is sometimes a sensible/effective approach.

For landslides, structural mitigation strategies are highly developed and non-structural measures are also emerging. However, the focus of such advancements tends to be developed countries. Possible **risk reduction strategies for resource poor rural areas include improvements in risk communication; hazard zoning the road**

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corridor to encourage settlements to develop in lower risk areas; the construction of feeder roads which enable communities to benefit from access to the road without being at risk from acute hazard events. However, these suggestions raise a series of questions regarding the targeting of already scarce resources and the governance of DRR. Nepal has, after all, recently emerged from a decade long civil conflict characterised by political instability and poor governance.

References

National Planning Commission (2007). Three Year Interim Plan 2007/8 – 2009/10. National Planning Commission of Nepal. Kathmandu.

Petley, D.M., S.A. Dunning and N.J. Rosser (2005). The analysis of global landslide risk through the creation of a database of worldwide landslide fatalities. *Proceedings of the International Conference on Landslide Hazard and Risk*, Vancouver, May 2005.

Petley, D.N., G.J. Hearn, A. Hart, N.J. Rosser, S.A. Dunning, K.J. Oven and W.A. Mitchell (2007). Trends in landslide occurrence in Nepal. *Natural Hazards*, 43: 23-44.

Websites

The International Landslide Centre: http://www.landslidecentre.org/

The Institute of Hazard and Risk Research, Durham University: http://www.dur.ac.uk/ihrr/

Dave's landslide blog: http://daveslandslideblog.blogspot.com/

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